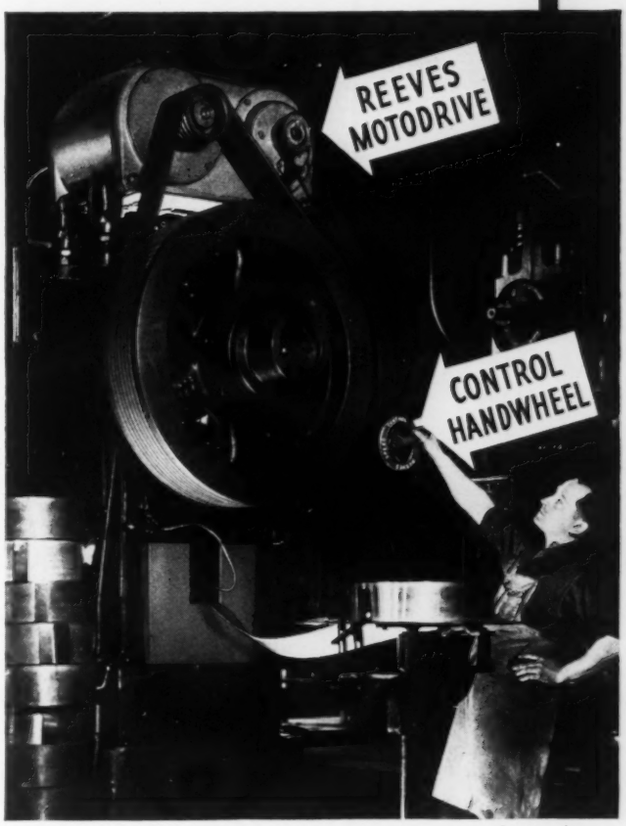
REEVES MAKES IT EASY

to Operate Driven Machines ACCURATELY



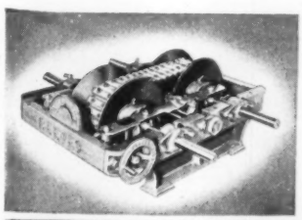
EVERY manufacturer and user of driven machines knows the importance of adjustable speed control. Variation in the kind and condition of materials, the size, weight, and shape of products, changes in temperature and humidity, affect the rate as well as the quality of production. In many cases the speed of one machine must be synchronized with the speed of another.

But the *ease and accuracy* with which these changes of speed can be made are vitally important, too.

If the *method* of speed control requires time, and causes trouble and inconvenience to the operator, the chances are that these changes will not be made as quickly or as often as they should. If only *limited* adjustability is provided there must always be a compromise. In either case, quality or quantity of production, or both, are affected.

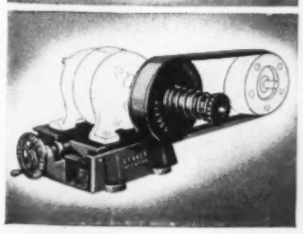
On the other hand, if a machine is equipped with REEVES Variable Speed Control there is no occasion for failure to change speeds, *instantly,* when the need arises. All the machine operator has to do is to turn a handwheel or push a button to obtain the exact speed required. Completely automatic control also available. And once changed, that speed remains constant, until changed again.

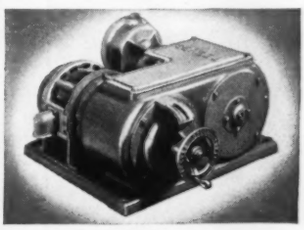
Builders of 1300 different makes of machines incorporate one or more of the three basic REEVES Speed Control units as standard equipment. Available in a wide range of sizes, designs, types and controls to meet your individual needs. Our engineering staff is nation-wide. May we serve you?



REEVES SPEED CONTROL

At left: REEVES Variable Speed Transmission for infinite speed adjustability over wide range and for heavy-duty service. . . . *Below, left:* Vari-Speed Motor Pulley, a simple direct drive for light horse-power requirements. *Below:* Motodrive which combines in one compact unit, motor, speed varying mechanism and reduction gears.





REEVES PULLEY CO., Dept. H-58, COLUMBUS, INDIANA

Please send information on your Speed Control units and their application to (machine or process):.....

NAME.....

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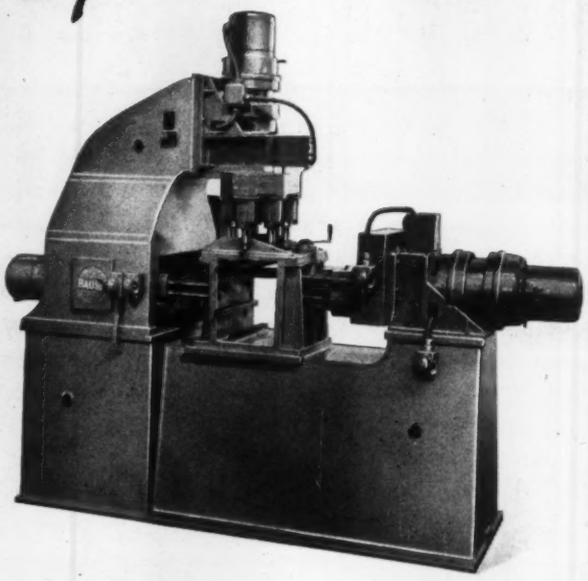

Reliance Disc-brake Motors are for power applications requiring quick, accurate, automatic stops or the holding of a load. The brake is a compact, disc-type friction device, mechanically and automatically engaged when the current is shut off and magnetically disengaged when current is applied. Get Bulletin 305 for details.

We present examples of motor-drive as thought stimulators. They may not match exactly your needs or processes, but they should emphasize that *there's a lot more than power involved.* It's our business to know motors and control and to think of them as they concern production and improved quality of your product. If you have ideas about using motor-drive, let's talk them over.

BAUSH 3-WAY LEAD SCREW TAPPER
with heads individually driven by Reliance A-c. Disc-brake Motors

Modern production tools like this tapping machine indicate that the designers have asked the question, "*What can we get the power unit to do besides provide power?*" Here, it combines in a single unit the functions of a motor with those of a powerful automatic brake. Flange-type mountings help make a compact and direct drive; parts are simplified, and electrical energy is transformed into useful work with a minimum of loss.

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RELIANCE A-C D-C MOTORS

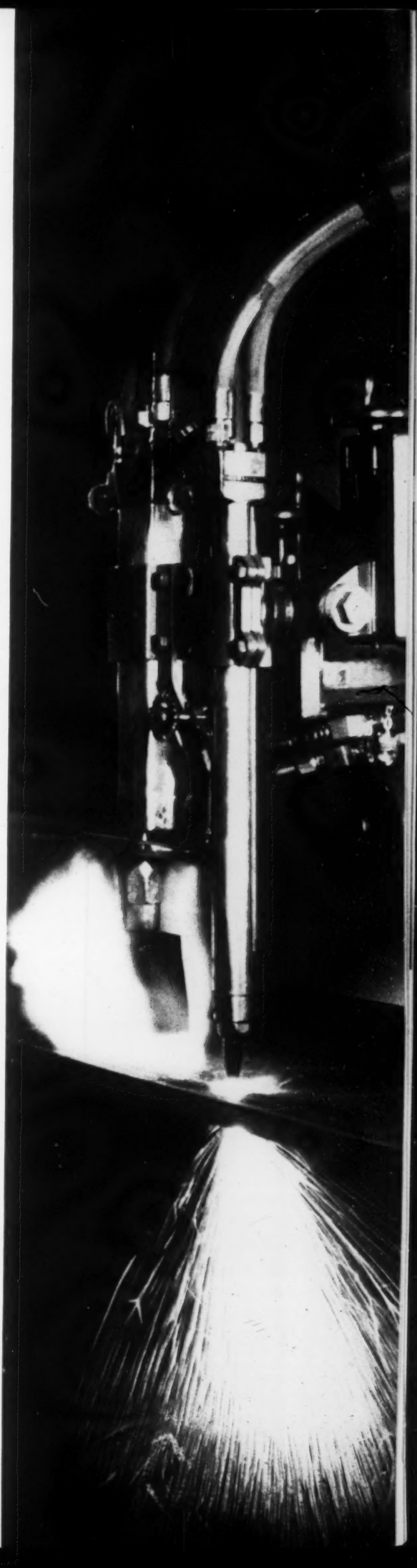
MACHINE DESIGN

New Technical Trails Are Blazed By Oxy-Acetylene Flames

By Guy Hubbard

CLASSED as a scientific curiosity well within the memory of many engineers still active in the profession, and considered more or less as a thing of mystery in the shop only a few years ago, the oxy-acetylene flame today is a tool which is as widely accepted in practical circles as is high speed steel or the cemented carbides. So rapid has been its penetration into the field of machinery production that engineers and designers do not in every case appreciate its effect upon and its possibilities in the design of machinery. Therefore, it is the object of this article to emphasize—with the help of a number of illustrations—some of the recent significant advances in flame cutting, flame softening and flame hardening.

The portable flame cutting machine, shown in action in *Figs.* 2 and 3, has been a potent element in advancing the use of "flame machining" in all sorts of metalworking establishments. The flexibility of this unit is perhaps its outstanding feature—straight line cutting, circle cutting, bevel cutting and shape cutting of both light and heavy plate being performed with facility. This machine can be brought to the work, which



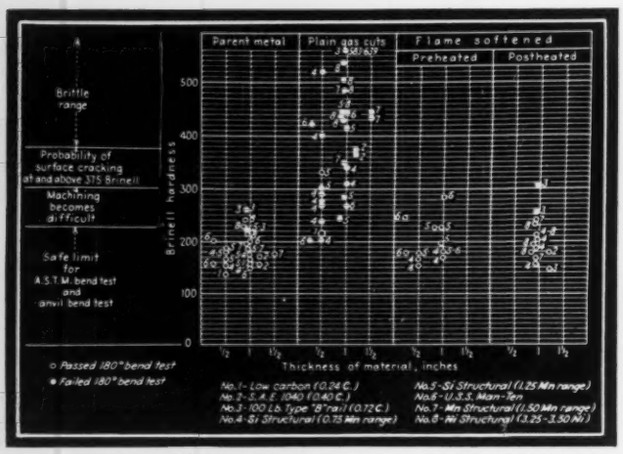
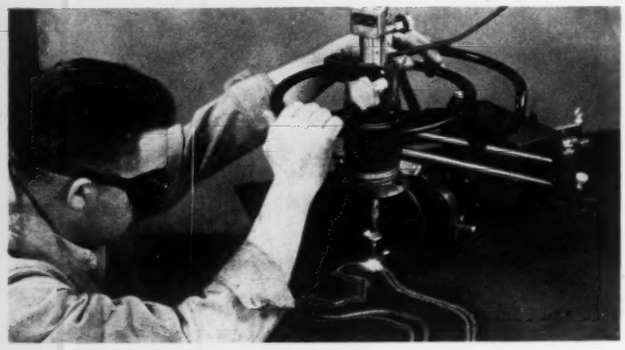

Parent metal
Plain gas cuts
Flame softened
Preheated
Postheated
Brittle range
Probability of surface cracking at and above 375 Brinell
Machining becomes difficult
Safe limit for A.S.T.M. bend test and anvil bend test
Brinell hardness
Thickness of material, inches
o Passed 180° bend test
• Failed 180° bend test
No.1- Low carbon (0.24 C.)
No.2- S. A. E. 1040 (0.40 C.)
No.3- 100 Lb. Type "B" rail (0.72 C.)
No.4- Si Structural (0.75 Mn range)
No.5- Si Structural (1.25 Mn range)
No.6- U.S.S. Man-Ten
No.7- Mn Structural (1.50 Mn range)
No.8- Ni Structural (3.25-3.50 Ni)

Fig. 1—Above—Effect of flame softening in reducing the hardness of flame cut edges of various steels

Fig. 2—Below—Use of the portable machine in the flame cutting of an irregular shape to exact contour



is highly important in many instances and set up is simple and quick.

In a production machine shop this type of machine can be kept continuously busy, either on special jobs or on regular manufacturing work—especially if the engineering department has proper appreciation of its possibilities and "designs for it". Its importance in connection with welded fabrication—especially in production of welded parts of pleasing appearance, as well as low cost and maximum utility—should be rather self-evident. With the help of relatively simple fixtures repetitive work can be performed with ease and rapidity and far more economically than by hand.

On low alloy, high strength steels commonly used in fabrication of machinery parts, flame cutting is inclined to produce a hardened zone along the cut edge. Where this hardness was objectionable, it formerly was the custom to remove the hard material by grinding. This was troublesome and expensive. Now the flame itself has provided the solution to this difficulty, through a new process known as "flame softening". As illustrated on the first page of this article, this process is ordinarily operated simultaneously with flame cutting. It effectively removes the undesirable edge hardness without recourse to further operations.

The process is not unlike flame hardening, which is described later, in that it is a localized and progressively-applied marginal heating operation effected by means of multi-flame heating heads. In purpose and in metallurgical aspects however it is diametrically opposite to flame hardening. In flame softening the multi-flame heads provide sufficient additional heat to the body of the metal to insure that the cooling rate of the cut surface will be considerably slower than it is with plain flame cutting. The effect of this procedure in reducing the edge hardness of a variety of steels is brought out by the chart, *Fig.* 1.

Significance of Time-Temperature Curves

While plates up to 3 inches thick can be softened by the use of a single multi-flame head directed at the top of the cut edge as depicted by the lead illustration of this article (Type No. 1 treatment in the graphs, *Fig.* 6) thicker plates must be dealt with in the manner illustrated by *Fig.* 4. (Curve No. 5 in *Fig.* 6)

Curve No. 1 in *Fig.* 6 indicates approximate slope of the time-temperature curve for preheating simultaneously with cutting. The effect is to retard the cooling rate following cutting (see lead illustration), thus allowing sufficient time for the development of soft structures. Curve No. 3 is for post-heating simultaneously with cutting. Temperature of the metal which has dropped rapidly following the cutting operation, is raised again to just below the critical point of the steel on heating. From this point the metal cools slowly to normal temperatures. Air hardening steels must not be reheated above the critical point. In the case of quench hardening steels, post-heating may be carried either to above (Curve No. 4) or below the critical point.

Curves Nos. 5 and 6 indicate types of time-temperature curves that are obtained when post heating from two sides, (Type 3 treatment) cutting and heat treating being separate operations. The heads used are of seven or 30-flame type and are water-cooled. Softening can be carried out faster than flame cutting in many cases.

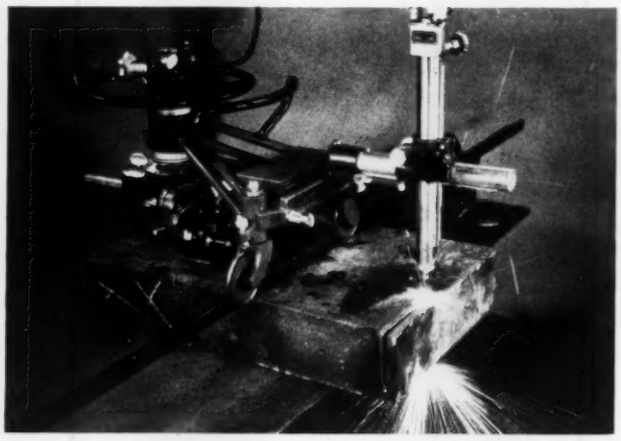


Fig. 3—Squaring up the edge of a thick steel plate with the portable flame cutting machine guided by a rail

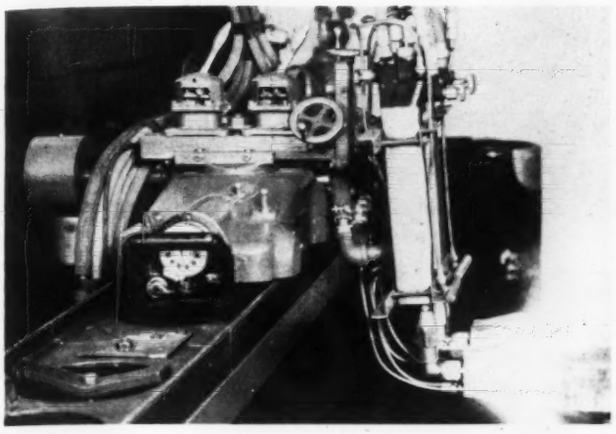


Fig. 4—Flame softening the flame cut edge of thick steel plate in accordance with Curve No. 5 shown below

In the Type No. 1 treatment referred to in *Fig.* 6, a single multi-flame heating head is directed at the top of the cut edge it being positioned either immediately before or after the cutting tip. This is for plate thicknesses up to 3 inches. Type No. 2 treatment, for thicknesses from 1 to 4 inches, is similar to No. 1 except that an additional multi-flame head is directed against the bottom of the cut edges. As thickness increases, simultaneous cutting and heating becomes impractical due to the deep, narrow kerf. Therefore in Type No. 3, the treatment is applied direct to the face of a cut edge after kerf is opened but before cut surfaces have cooled to room temperature.

Since a neutral flame is employed for flame softening, the multi-flame heads consume approximately equal parts of oxygen and acetylene. For estimating purposes the volume of oxygen and acetylene for softening a plate 1 inch thick by the simultaneous Type No. 1 treatment, can be figured at approximately 2 cubic feet of each gas per linear foot of cut for each side of kerf softened.

The advantages of localized hardening of machine parts is thoroughly appreciated by machine designers and for years various expedients have been used to bring about this effect. Flame hardening, which is one of the most recent answers to this important problem, is unique in that it imparts a hardened surface to steel at any points required, without in any way altering the chemical composition of the steel. The flame hardening of surfaces of sections as thin as ⅜-inch is readily possible. The hardness obtainable is at least equal to that obtained on steel of the same analysis by furnace hardening methods. Because the part is very briefly raised above the critical point and then quenched promptly, it remains scale free. In most cases distortion remains well within manufacturing tolerances—especially on fairly thick sections. Case depth can be controlled within reasonable limits.

In general, any steel that can be hardened by simple heating and quenching can be treated successfully by the flame hardening process. In addition, cast iron and alloy cast iron can be flame hardened, as will be made clear further on. The most desirable steels for flame hardening are those of low alloy variety. These usually harden to a good degree and withstand the heating and quenching without checking and crack-

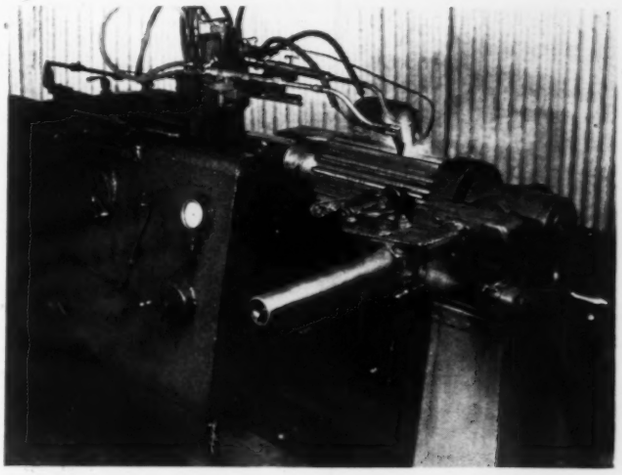
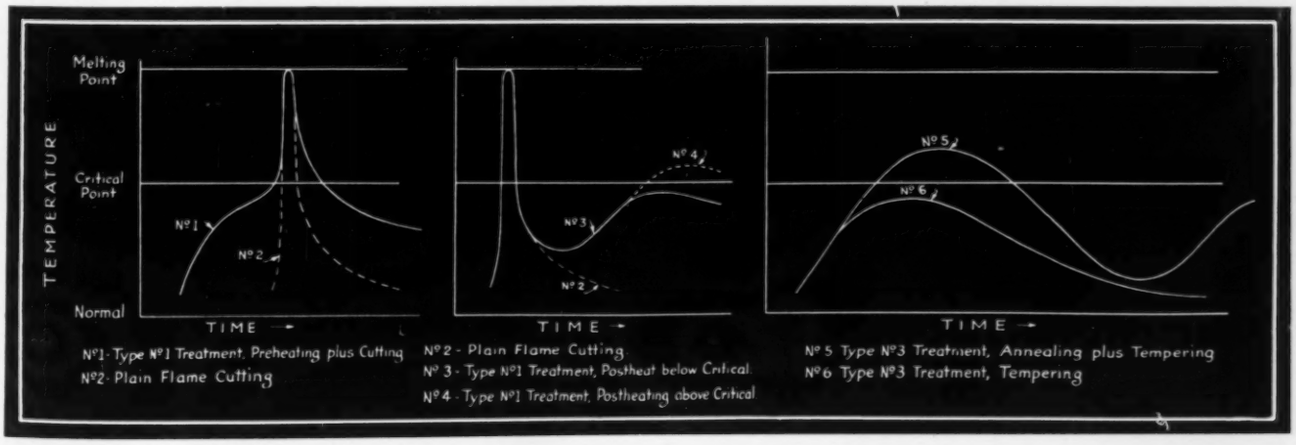


Fig. 5—Above—Flame hardening teeth of long, heavy duty pinion, quench being integral with flame heads

Fig. 6—Below—Time-temperature curves for three types of flame softening used for different conditions



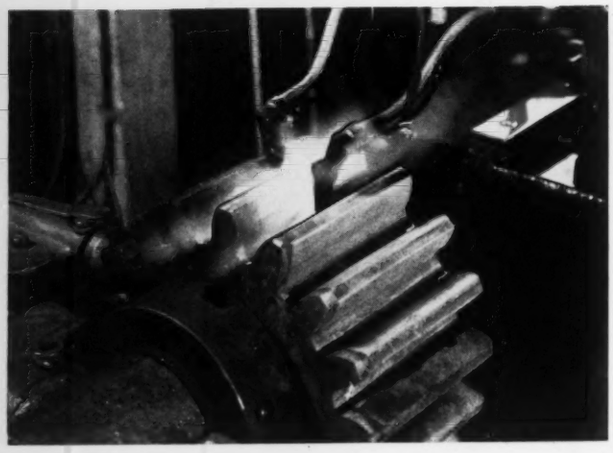


Fig. 7—Closeup of flame hardening operation on a gear, such teeth often being hardened in one minute each

ing. Flame hardening can be and should be carried out mechanically, either by special equipment such as is shown in *Figs.* 5, 7 and 8, or in a lathe. A lathe is readily adapted for flame hardening, the blow pipe being mounted in the tool post for smooth horizontal motion along the work which is mounted along side of, or in the lathe—circular work being revolved.

There are four conventional methods of flame hardening: Stationary; progressive; spinning; and combination. Stationary includes operations where blowpipe and work are motionless as in "spot hardening" of automotive valve stems. The progressive method is that where blowpipe and work move with respect to each other—a notable example of which is the operation on the Monarch lathe bed shown by *Fig.* 8.

In the usual setup for flame hardening a plane surface, the lighted blowpipe with a head having sufficient flame area to cover the path to be hardened, is directed along the surface at maximum speed at which the material will heat to hardening temperature. Immediately behind the flame is a stream or spray of water which progressively quenches the heated surface. Speed of flame travel depends upon flame intensity, type of steel, temperature, depth of case and other variables and so will vary from 4 to 10 inches per minute, the usual speed being 6 to 8 inches.

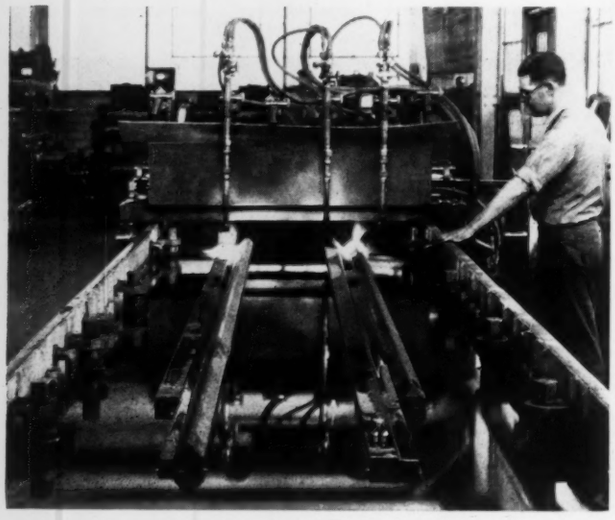


Fig. 8—Flame hardening bed ways of a Monarch lathe, the bed being immersed in water to prevent distortion

The oxy-acetylene apparatus should be rugged and flexible, and must be water-cooled. Water for cooling and water for quenching preferably should be controlled separately. The quench should follow the flame as closely as possible without interfering with it. For gear tooth hardening, such as that shown by *Figs.* 5 and 7, special heads are used.

A notable example of what can be done through flame hardening is given by the process recently perfected by The Monarch Machine Tool Co. in connection with certain of their precision lathe beds, on which patent is pending. The photograph, *Fig.* 8, reveals the actual flame hardening of one of their 24-inch lathe beds. This bed, which is 25-inches wide and 14-feet long overall, is immersed in a water tank with the exception of the planed ways upon which the flame heads are progressively acting. In this way the body of the casting is kept at normal temperature, effectively preventing strains.

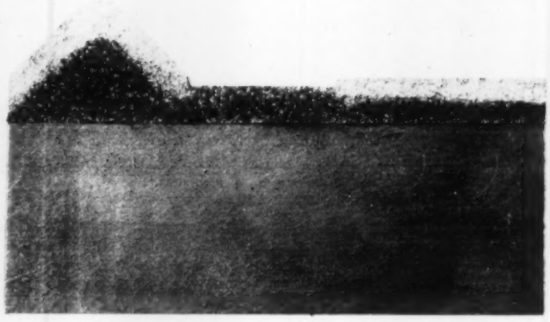


Fig. 9—Section through V and flat ways of Monarch flame hardened bed showing effect on grain structure

Following this flame treatment the ways are surface ground to a tolerance of 0.0005 inch, whereupon they have the appearance of hardened steel. As is shown clearly by the etched fracture, *Fig.* 9, which is from an unretouched photograph, the grain structure of the entire hardened portion, which is ⅛-inch or more in depth and tests to 590 Brinell, is greatly refined and condensed. Incidentally the metal directly under the hardened sections is unusually dense and close grained, averaging 220 to 230 Brinell or more, thus giving rigid support to the hardened sections.

For the unusually fine and interesting illustrations used in this article, as well as for the information and data on which it is based, MACHINE DESIGN is indebted to The Linde Air Products Co. and to The Monarch Machine Tool Co. Without their generous cooperation such a presentation would not have been possible.

Scanning THE FIELD FOR Ideas

ONE of the highly significant trends apparent in modern machine design is the extent to which mechanisms of very large size are being made dependent upon extremely small mechanisms. In other words, big machines in numerous instances are being equipped with sensitive and ingenious "mechanical brains" which to a surprising degree can "sense" conditions and cause the huge machine instantly to meet them—as in the following example.

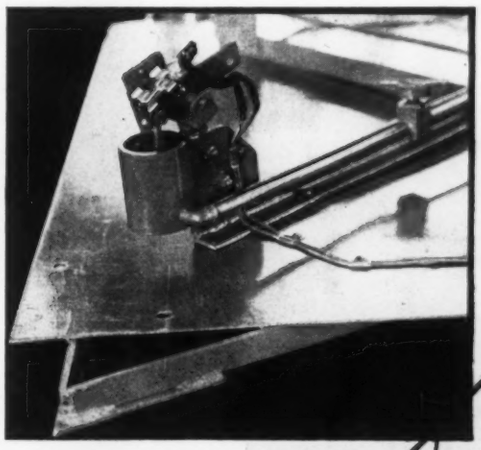
Tiny Units Balance Huge Shovel

AUTOMATIC leveling through "sense of balance" achieved electrically is an important feature of the Bucyrus-Erie giant shovel for strip coal mining, shown in *Fig.* 1. This is said to be the world's largest structure capable of overland movement on its own traveling foundation. A patented arrangement involving the use of four General Electric mercury switches, one at each corner of a plane table, acts to keep the 2,500,000-pound structure always "on an even keel" even when its four tractor units are moving over decidedly uneven ground. One corner of this plane table, with its mercury switch and mounting thereof, is depicted by the insert at the upper left-hand corner of *Fig.* 1, adjoining.

The mercury switches act through boosters in such a manner as completely to control interlocking and electrical devices, fluid valves and pumps. When the shovel tends to settle, the control table—normally horizontal—tilts with the machine, causing mercury to flow from one end of the switch tubes to the other. This completes a circuit which controls oil flow, including operation of four independent, electrically-driven high pressure pumps.

Under each corner of the base is a heavy duty, double tread crawler tractor unit similar to a military tank, each with individual electric drive. The "legs" connecting these tractor units to the base actually are powerful oil-operated hydraulic jacks. Whenever settling occurs at any corner or any side, one or more of the automatically controlled pumps already mentioned are caused by mercury switch action instantly to deliver the necessary amount of oil to one or more of these jacks, or if a corner or side rises and lowering is required the proper valving of oil is accomplished by action of the mercury switches. As the hydraulic jacks return the structure to level condition, the built-in control table is likewise leveled, whereupon the mercury switch circuit is opened.

In operation, this system of automatic leveling has been found to result in substantial power saving, by doing away with the need for swinging the machine "up hill". Also, it saves valuable time by eliminating



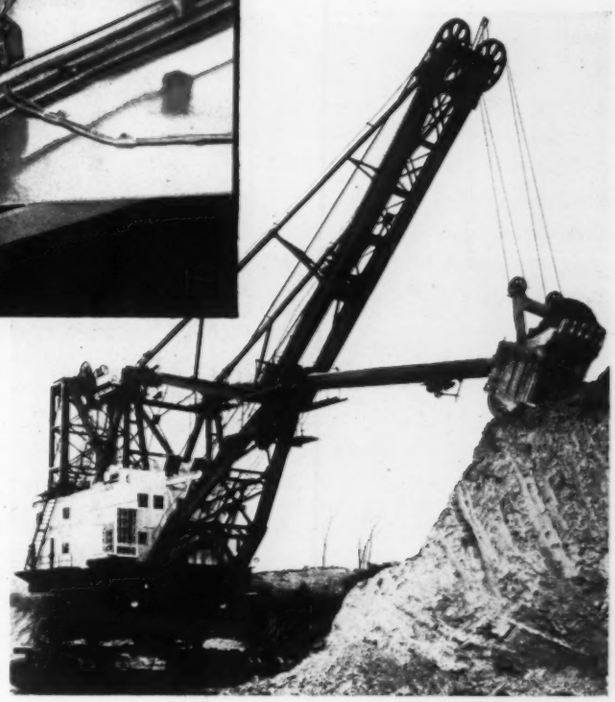


Fig. 1—Tiny mercury switches, as at left, level huge shovel shown below

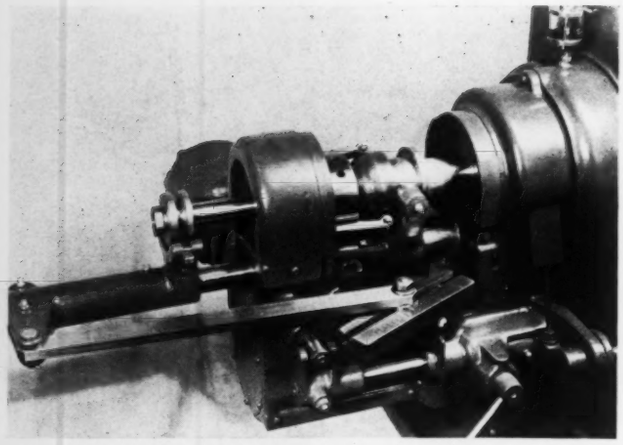


Fig. 2—Power is applied to bar feeding and chucking in this turret lathe, thus further relieving operator

interruptions in the digging cycle incidental to manually controlled leveling.

This huge electric shovel had to be assembled on location on the properties of the Binkley Coal Co. of Missouri. It has dipper capacity of 33 cubic yards, equal to capacity loads for more than ten 5-ton trucks. Towering over 100 feet high, the machine has a 105-foot boom and could easily dump its load on top of a seven story building. Thirty-two electric motors mounted in the structure total 2400 horsepower.

Motor Eliminates Manual Feeding

POWER feeding and chucking of bars in several models of Warner & Swasey turret lathes can now be accomplished by a newly developed mechanism of which a close-up (with guards removed to reveal the graduated, adjustable feed arm and other details) appears above as *Fig.* 2. Its control ordinarily is from a single hand lever located near the cross slide (not shown), but in some cases the device can be arranged to be tripped automatically by operation of the cross slide, even when tools are used at both front and rear stations. In that case, for such fast operations as forming and cutting off short pins, the operator need only move the cross slide lever to obtain a complete cycle. This reduces time per piece and fatigue.

To anyone at all familiar with turret lathe design and with modern developments of what used to be called the "Parkhurst wire feed system", it will be obvious that the elements of conventional bar feeding and chucking, their adjustment, and the sequence of their operations, remain in the same simple, time tried form and relation as for manual actuation. This new design simply introduces the power of an independent fractional horsepower motor (visible behind the mechanism), reduction gearing, levers, suitable timing control and stroke adjustment in place of "man power" and step-by-step manual control. The coolant pump, which ordinarily is driven from the machine spindle, is driven by the independent motor just mentioned when this power feed system is used. Note that pressure greasing is provided for, this being indicated by the nipples at all points where lubrication is required.

Bar stock up to 1-inch round can be fed up to 6 inches in one stroke on the larger machines, longer feed being attained by operating the mechanism more than one cycle. A simple shifting of a selector lever sets the device for second operation work where no feeding motion is required and the collet chuck must remain open at the end of the cycle for hand insertion of the work piece at the spindle nose end.

Streamlined Reducing Valve

OPERATION of steam, hydraulic and compressed air apparatus frequently entails the use of a pressure-reducing mechanism which can be set to give proper working pressure from a high pressure line.

Depicted by *Fig.* 3 is a pressure reducing valve designed by the A. W. Cash Co., in which not only has

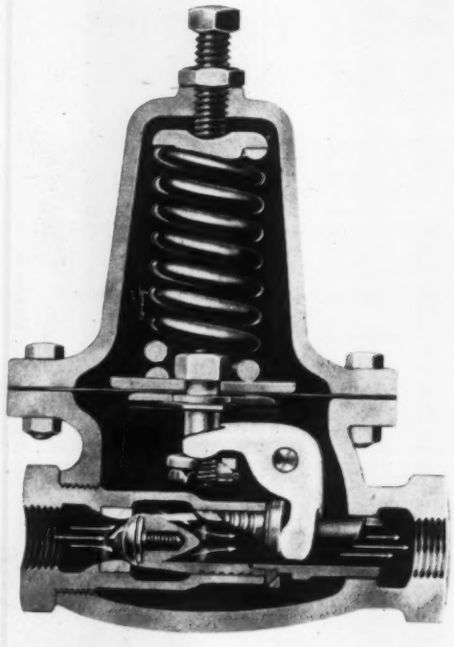


Fig. 3—Streamlining in true sense of the word is attained in this pressure-reducing valve

mechanical simplicity been attained but in which the principles of "streamlining" are applied effectively.

In this device, venturi approach to the valve opening is provided, following which there is slight bending of flow around the streamlined reducing valve head, followed by straight, unobstructed flow at the lowered pressure on into the line. The pressure control chamber below the diaphragm communicates with

the reduced pressure chamber only through the small annular space between jet and housing (see lower right in cut). As the valve opens, velocity of the straight line flow past this annular passage produces a suction effect which lowers the pressure in the control chamber well below delivery line pressure, thus getting the valve wide open to meet the demand and holding delivery pressure constant.

Quiet Motor Has Herringbone Rotor

HERRINGBONE construction has been adapted to the rotors of induction motors by Sterling Electric Motors, Inc., to insure silent operation, at the same time eliminating end thrust. One of the rotors of this design is shown in *Fig.* 4, this "squirrel-cage" rotor being of laminated type, with the conductor

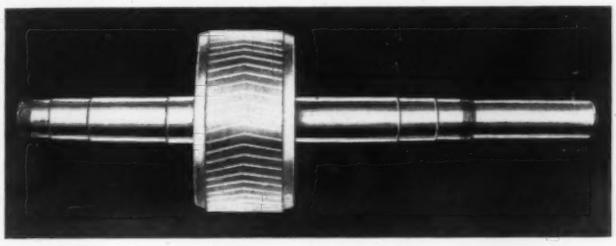


Fig. 4—Herringbone design of rotor eliminates noise and endthrust in squirrel cage induction motors

bars pressure-cast into the herringbone slots. The herringbone shape of the slots is attained by staggering the punched laminations—each with its notches slightly ahead of or behind the one next to it.

If this rotor be considered as turning upward and away from the observer, with the apex of any conductor bar adjacent to one of the "straight across" stator slots, it is evident that any subsequent movement of the rotor will cause this stator slot to be "bridged" by symmetrical portions of the conductor bar. Thus there is no end thrust, as the endwise forces exactly balance each other.

Engine Head Is of Copper Alloy

DESIGNED by the Federal-Mogul Corp. as a replacement unit for Ford 85-horsepower engines, the power head shown in *Fig.* 5 embodies a number of interesting engineering features.

Cast from a special copper alloy and using a "spot and fin" cooling principle, over-heating, freezing and sudden chilling are eliminated and ideal combustion chamber temperatures are said to be maintained under operating conditions with little or no oil dilution or carbon formation. So great is the heat-dissipating ability of this head that it actually can not be cut by an acetylene torch.

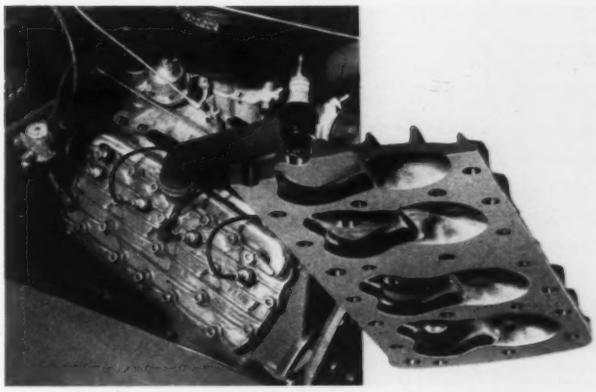


Fig. 5—Replacement head of copper alloy utilizing "spot and fin" cooling, promotes motor efficiency

High compression ratios, increased power and mileage and quick acceleration are among the ends claimed to be attained by these heads.

To Readjust, Peel These Shims

THE photograph *Fig.* 6, below, taken in the plant of the Ideal Power Lawn Mower Co., shows assembly of the transmission of a mower tractor unit.

Mechanisms of this kind must be designed not only to withstand hard service under unfavorable conditions, but also with the thought in mind that they will in many cases have to be "serviced" by unskilled persons with scanty mechanical equipment.

Therefore, the shims which are here being installed are of the "laminated" variety. While they act as solid shims in this original assembly, adjustments which eventually may be needed to restore alignment and accurate gear-to-gear contact will be accomplished with precision simply by "peeling" these shims—no filing or machining being required.

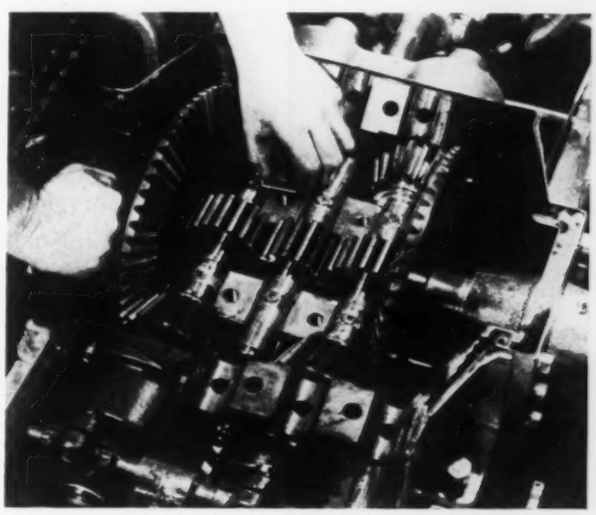
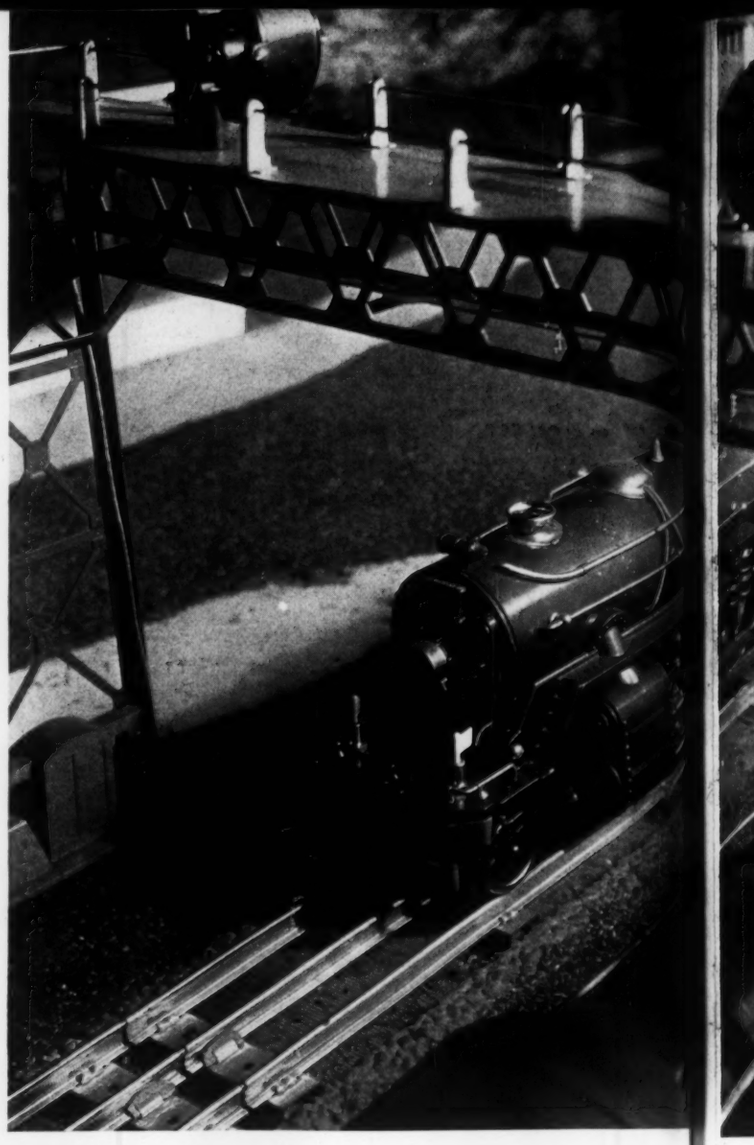


Fig. 6—Original assembly with laminated shims insures effective servicing with minimum of facilities



Advanced Engineering

By Joseph Bonanno*

TOYS as a rule, though often ingenious, do not incorporate very intricate or sound mechanized design. Built to last only for a short time, the effort of the designer goes into making the various parts of easily formed stampings that may be assembled with a minimum of time and expense. It is somewhat surprising to learn, therefore, that in one field of toy design to obtain realism and smoothly functioning mechanisms, shrewd use of materials and parts has been made. Toy trains made by the Lionel Corp. perform like real trains; locomotives are exact replicas of their big brothers.

The first Lionel train ever made, over thirty years ago, consisted of a flat car made largely of cast iron, running on a two-rail track of flat wire. The flat wire was set on edge in wooden ties. Electricity was furnished the motor through the wheels, insulated from each other by wood or fiber bushings. Neither switches nor crossings were supplied and aside from watching the train run 'round and 'round the model railroad enthusiasts could only add to their enjoyment by occasionally reversing the direction.

Today by the application of suitable electrical equipment the locomotive can be started, stopped, reversed, made to go fast or slow and whistle in railroad style —all from a single control box situated some distance from the train. Electrically-operated switches and other accessories add to the realism of a miniature train.

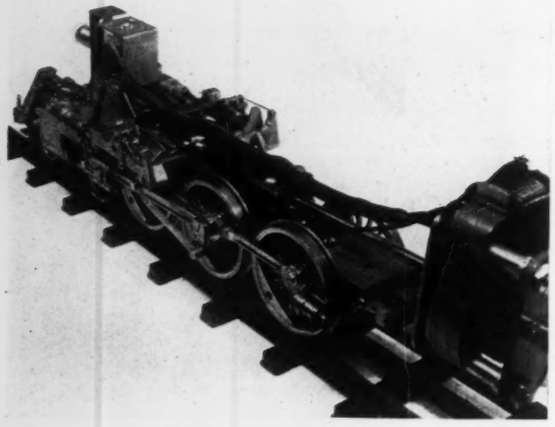
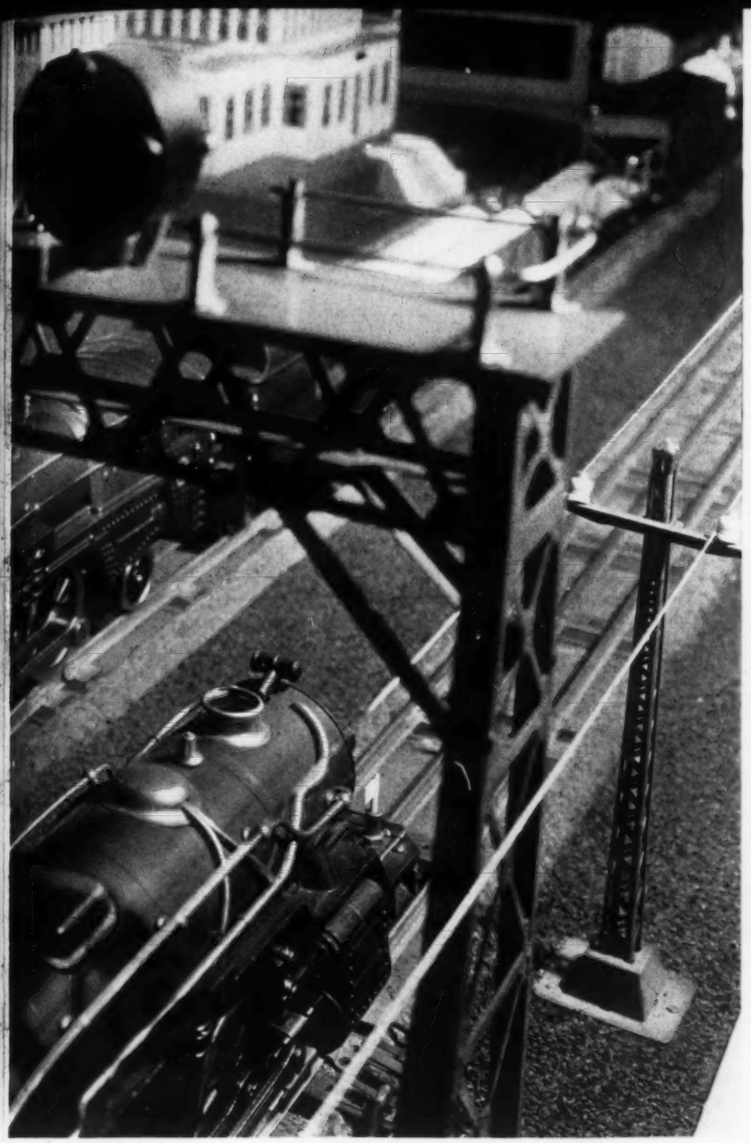


Fig. 1—Upper view—Single die casting produces cab and boiler unit on which rivet heads, steam domes, etc. appear in minute detail. Lower view shows electric motor and worm drive mechanism of model locomotive

Early locomotives were made almost entirely of tin-plate which was used to facilitate soldering. Iron castings were used for the wheels and brass trim for the cab and chassis. Heavy slugs had to be added to maintain the minimum weight required for traction. Track was improved by forming tinplate rails to an approximate "T" and fastening these rails to tinplate ties.

Within the last seven or eight years the trend of miniature locomotive styles has been toward steam types with electrical propulsion from step-down transformers. This last change necessitated the substitution of laminated armatures and fields in the motor

*Chief engineer, The Lionel Corp.



Underlies Toy Trains

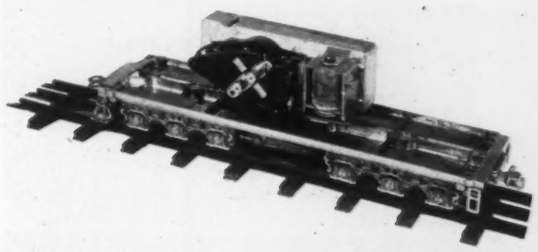
for castings. At first these parts were made of ordinary cold rolled steel but lately with improved methods of production it was found advantageous to utilize low silicon content coiled electrical steel.

Die castings have been adopted for a multitude of parts and are largely responsible for the realistic detail that is apparent in scale model locomotives. All in all, there are 79 zinc alloy die castings, representing 65 per cent of the total weight in the large size, scale model locomotive. These die cast parts not only impart realistic detail but the first and thousandth casting will be identical in dimensions—reducing assembly problems to a minimum. *Fig.* 1, upper view, shows a cab and boiler combination which is a single die casting after the stanchions and pipes have been attached. The model is true to the real machine even down to the tiny rivet heads.

As can be seen in the lower view of *Fig.* 1 connecting rods, driving wheels and other moving parts carry out the realism that accounts for the popularity of these toy trains. The model shown is powered with an electric motor and propelled through a worm drive which runs in oil. Whereas a few years ago axles ran in punched or drilled holes in the steel side plates, practically every bearing of importance in the engine today is bushed with either a bronze turned bushing or a porous oil retaining bronze molding.

Bright parts of the trains have been finished in nickel plate but are now supplemented by other processes including black oxidizing, cadmium plating and chromium plating, the latter being used in increasingly large quantities. Painting has been modernized by the use of synthetic finishes baked at low temperatures.

Fig. 2, upper view, depicts the train tender framework with a motor-driven whistling unit installed on it. Design of trucks and electrical pick up are shown in the lower view of *Fig.* 2. Though not an unusual design, the incorporation of a signalling device of this sort indicates the effort to make toy trains the counterpart of real machines. Boys fortunate enough to have the opportunity to play with toys of such fine workmanship will certainly grow into men with an appreciation of engineering achievements.



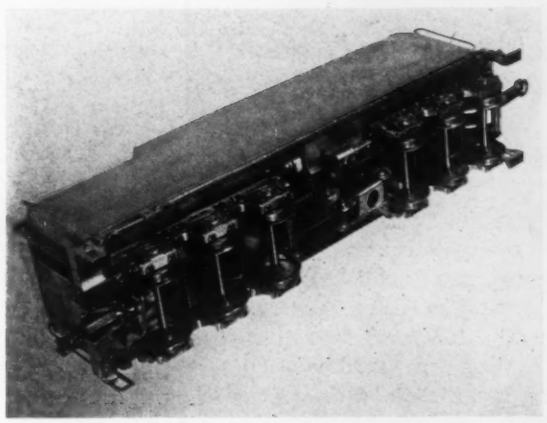


Fig. 2—Upper view—Motor driven whistle, actuated from train control transformer, is mounted on tender framework. Tender trucks, lower view, illustrate care taken to make them exact replicas of real wheel mountings of railroad car

Higher Strength Widens Scope of Plastics

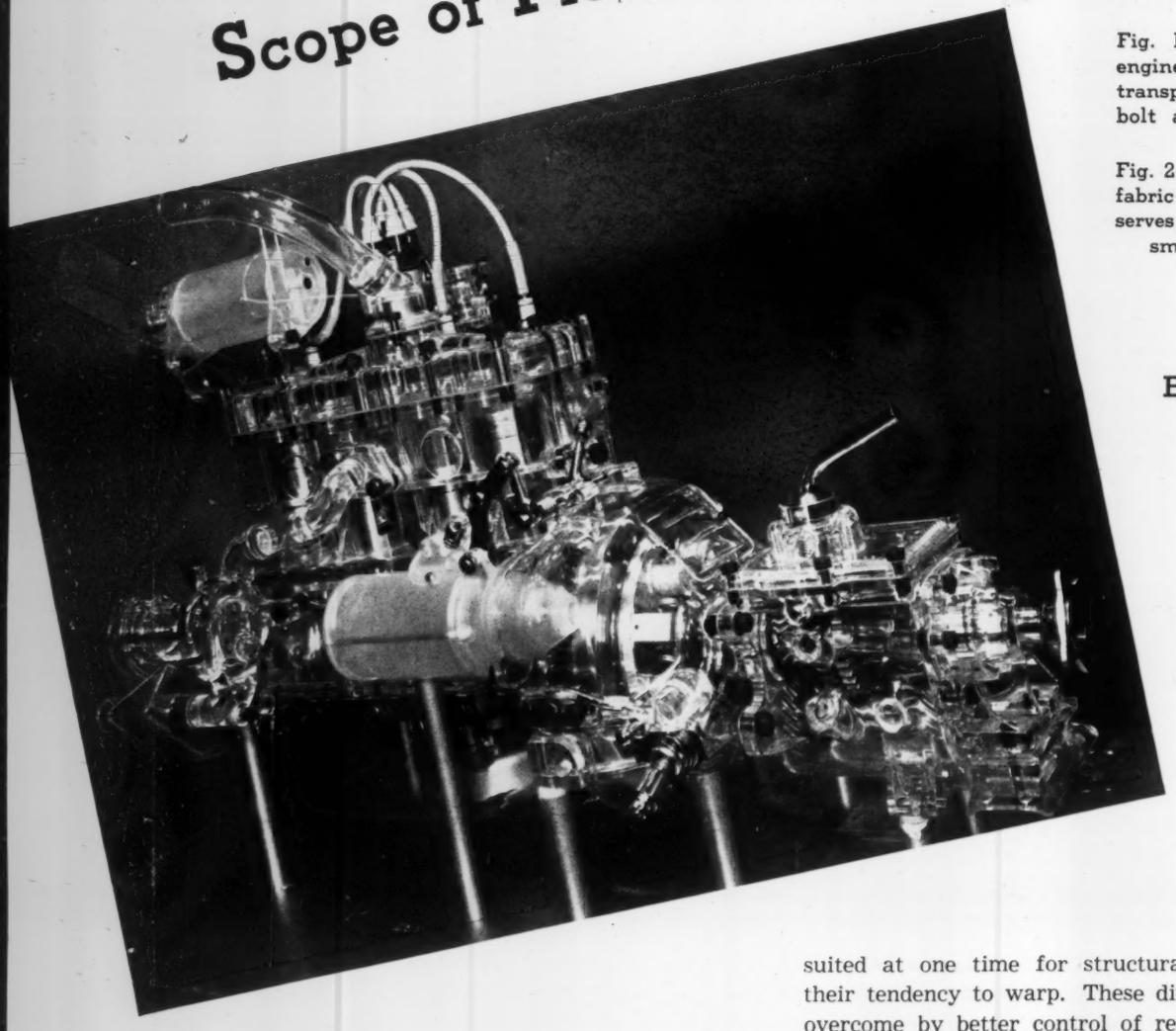


Fig. 1—Left—German auto engine is made entirely of transparent plastic to show bolt and nut applications.

Fig. 2 — Above — Shredded fabric filled phenolic housing serves admirably to enclose small electric eraser

By J. Delmonte

PLASTIC materials have always been noted for their beauty and permanence of finish, good insulating qualities, moldability, economy and simplicity in design, and lightness of weight. Until recently, however, they have been relegated to the background in structural and mechanical designs, though with the development of new high-strength materials this attitude is changing rapidly. Molded products, once regarded as too brittle for many purposes, are now strengthened by impact-resisting fillers or by the selection of tough, cellulose plastic molding compositions. The laminated plastics were also unsuited at one time for structural purposes due to their tendency to warp. These difficulties have been overcome by better control of resin content and by selecting more appropriate bases. In addition, recent developments of special paper and thin wood veneer bases have produced materials with high directional tensile strengths of about 25,000 pounds per square inch with the grain, though appreciably less when measured crosswise.

Before discussing practical methods of obtaining greater strength from plastic materials, an analysis of the inherent behavior of the pure resin entering into the manufacture of plastics may be enlightening. The greater proportion of hot molded compositions are derived from the following resins: Phenol-formaldehyde, urea-formaldehyde, and cellulose acetate plastics. The first two are of the thermosetting

type, becoming hard and infusible after molding under heat and pressure. In the absence of proper fillers, the resin becomes hard and brittle. The presence of fillers alleviates this condition and improves the mechanical characteristics. With the addition of the plasticizer, greater toughness is exhibited by the molded cellulose plastics and they become more flexible and better adapted to engineering purposes. The cellulose acetate plastics are handicapped in one respect—they will soften on applying too much heat, being essentially thermoplastic in nature. In brief, phenolic and urea plastics are improved in toughness and strength by the addition of the proper fillers, and cellulose plastics benefit in a like manner by the addition of plasticizers.

Fillers Improve Mechanical Characteristics

Different fillers play an important part in improving the mechanical characteristics of molded phenolics as do various bases in laminated products. One of the common though more brittle types of molded plastics is that employing a wood-flour filler, which finds very broad application. Though its impact strength is low, high quality, lustrous finish and good molding qualities influence its selection. When greater strength is imperative, even at the sacrifice of appearance, other fillers are used. The plastics are tabulated below in accordance with an increasing impact strength, as imparted to them by various fillers and bases. In general, the longer the fiber of the filler, the higher the impact strength.

1. Molded phenolic—wood flour filler—low impact strength
2. Molded phenolic—cotton filler—low to medium impact strength
3. Molded phenolic—shredded fabric filler—medium impact strength
4. Laminated phenolic—paper base—medium to high impact strength
5. Laminated phenolic—canvas base—high impact strength
6. Laminated phenolic—wood veneer base—very high impact strength.

When high impact strength is desired in a molded piece, a shredded fabric filler is used. From a viewpoint of the custom molder this entails not only a higher priced material, but also a difficult molding composition inasmuch as it is not usually tabletted and must be handled in bulk form. A typical example of a shredded-fabric molded phenolic housing is that of the portable electric eraser shown in *Fig.* 2. Though the finish is not so pleasing to the eye as a lustrous black and the part does not machine as well, from physical and structural standpoints it has many advantages. A housing of this description is light, durable, and will withstand rough handling. On the other hand, a telephone handset that must have a neat and attractive appearance is often molded with a cotton filler at the expense of some impact strength. Subject to frequent handling, it must combine greater impact strength than that offered by the less expensive wood-flour filled plastics, and also possess better appearance than attainable with shredded fabric.

Though the cellulose molded plastics combine great toughness with good appearance, they have not offered great competition to phenolic plastics in mechanical designs in the past due to their higher cost. Of the two applications just discussed, a molded cellulose plastic, such at Tenite, has been attractively applied to telephone handsets. Its superior toughness insures non-breakage of the unit. On the other hand, there may be some question of the utilization of this material on a motor housing where elevated temperatures would not only soften the cellulose plastic but promote volatilization of the plasticizer, causing embrittlement of the material.

The importance of pure alpha-cellulose fillers to molded urea plastics warrants more than passing comment. The cellulose does more than act as a filler—research indicates a chemical reaction with the urea-formaldehyde. The final product is vastly improved from mechanical and structural standpoints over a primary urea plastic uncombined with a cellulose filler. With increased data on fillers for molded plastic design, engineers are in a better position to reconsider earlier rejections of plastics in design because of brittle characteristics.

Decided structural and mechanical advantages are obtained by combining laminated and molded plastics

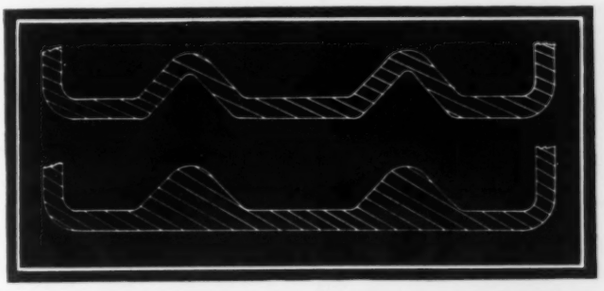


Fig. 3—Preferred method of forming ribs in plastic molding is shown in top view. More material is used in lower style and finished piece is no stronger

into an integral product. The unlimited possibilities of this development should inspire the ingenuity of designers. It is accomplished by introducing the incompletely cured laminated plastic, shaped to approximately the form it is to assume, into a mold cavity with preforms of the molding powders. The entire mass is molded in the usual fashion under heat and pressure. It is important that the resin flow almost simultaneously in the laminated piece and in the molding material to make a complete and solid bond at the interstices between the two pieces. In effect, this is equivalent to a welding operation and, once set, it may not be fused again if thermosetting materials are used. In this manner the strong canvas-base laminated plastics with tensile strengths of 14,000 pounds per square inch may be used to

advantage where they are most needed.

One important design of the rayon spinning bucket utilizes a combined molded center piece and a shell of laminated canvas, phenolic plastic. The addition of the latter gave needed strength to a part that was subject to excessive mechanical strain while rotating at high velocity. In recent models of certain switches and electrical accessories, parts that previously experienced failure due to mechanical shocks were redesigned to include the added reinforcement of a strong, high impact canvas, laminated plastic. The

Fig. 4—Although receiving hard service from airplane vibration and wide temperature changes, transparent plastic for cockpit housing does not fail

success accompanying these particular units has been encouraging.

Recently, manufacturers have produced a group of molding boards and blanks designed to bridge the gap between molded and laminated plastics. These resin blanks, as they are sometimes called, are produced in sheet form by combining phenolic resins and fibers on paper making equipment. The molding board with the unpolymerized resin is adaptable to comparatively flat and simple mold cavities and will give products with an impact strength greater than that obtainable with molding compositions. Blanks are cut from the board and molded into final shape with the addition of a small amount of molding powder. They have been applied as reinforcing materials for metal lugs and inserts in control switches, to refrigerator breaker strips, tray tops, etc. The molding boards are available commercially up to .141 inch in thickness.

There are several ways of increasing the strength of molded plastic parts. One, described above, suggests the combination of uncured laminated plastic with the molding powders. Simpler alternatives are available if not too great an increase in strength is necessary. Inclusion of well-rounded corners and substantial ribs for stiffening large areas of molded, unsupported, plastic surfaces is one method. The design of the ribs is not always to the best standards of structural practice. *Fig.* 3, below, is a cross-section of the common method of introducing ribs on plastic surfaces, and the upper view shows a preferred style. The first method has one advantage in that material flow conditions during molding are improved. Not only is economy of material realized in the latter design, but also added strength. Moreover, the maintenance of uniform thickness in the molded cross section simplifies the molding procedure. When uneven thicknesses prevail, a longer time is required to insure the complete cure of the thicker portions. Among other design features contributing to a weakened molded part are:

(a) Walls too thin about molded inserts

(b) Inadequate molded body supporting molded threads

(c) Tolerances too close on metal inserts to which a solid metal piece is to be attached by screw thread parts.

The above points are causes for frequent breakage of molded parts and the proper elimination of such undesirable features would help matters. However, when the correct design technique has been observed and the part still fails to respond, consultation with the custom molder and an examination of a possible deficiency in molding materials may reveal the true explanation for the difficulties. Perhaps better fillers may be selected or materials more thoroughly impregnated by the resin.

Cellulose plastics and other thermoplastic materials are capable of being extruded into large channels, bars and tubes under high pressures of 5000 to 20,000 pounds per square inch. Though the low moduli of elasticity (See Table I) precludes their use as load supporting members (giving large deflections under load) the extruded forms are suitable as conduits for chemicals and as housings to resist climatic conditions. In addition to the cellulose plastics there

TABLE I

Typical Plastic Material	Modulus of Elasticity (lbs. per sq. in.)	Tensile Strength (lbs. per sq. in.)	Specific Gravity
Cellulose Acetate—Sheet	100,000– 300,000	6,000– 9,000	1.27–1.37
Phenol Formaldehyde — (Molded Fabric Filler)	700,000–1,500,000	6,000– 8,000	1.34–1.40
Phenol Formaldehyde (Laminated Canvas Filler)	500,000–1,500,000	10,000–14,000	1.30–1.40
Urea Formaldehyde (Molded Cellulose Filler)	1,000,000–1,500,000	8,000–11,000	1.48–1.50
Methyl Methacrylate —Sheet	600,000– 800,000	7,000–10,000	1.18
Polystrynene—Molded	450,000– 500,000	4,000– 7,000	1.06
Hard Rubber	500,000	4,000–10,000	1.12–1.80
Vinyl-Chloro-Acetate	350,000– 400,000	8,000–10,000	1.35

are vinyl, acrylic and styrene resins which have found miscellaneous applications in extruded forms. In order to minimize the residual stresses in thermoplastic tubes it has sometimes been the practice to avoid seamless articles by passing in a continuous process a thoroughly warmed flat strip through a forming die. A hollow cylinder is formed with the abutting edges joined in a seam. Extruded tubes of

vinyl chloride have been applied quite extensively abroad under the tradename "Mipolam." Frequent references in German literature describe their use in conduit, conduit fittings, and attachments for chemical apparatus.

Thermoplastic resins have also been applied to electrical conductors as an extruded sheathing. Though their application as impregnating agents is old to the art, in a solid tube form their application is novel. Polystyrene is one material that has been so applied. In another, acrylic resins were proposed as substitutes for lead sheathing over cables. Of course, there are certain temperature restrictions depending upon the softening points of the materials. Other structural applications of interest among thermoplastic materials are those utilized in model construction. The large, transparent model of the new Mt. Wilson telescope, (MACHINE DESIGN, June, 1937), has been featured prominently. In addition, the usefulness of cellulose plastic models to photoelastic study is well known. A most unusual use of a transparent plastic is that of *Fig.* 1, in which a German bolt manufacturer has made an entire auto engine of plastic material.

Transparent Plastic Sheets Practical

The cellulose derivatives, though offering greater toughness and resistance to impact, have several shortcomings. The plasticizer content imparts other desirable qualities to cellulose acetate plastics. For most practical purposes, under normal conditions of environment, the plasticizer content will remain with the plastic products for a long period of time, but it will occasionally volatilize with age and embrittle the product. This behavior has been particularly true for large sheets where a great ratio of area to weight exists. Concentrated research upon this problem has tended to improve the quality of plasticizer content and retard the volatilization.

Large sheets of cellulose acetate and more recently methyl methacrylate have been applied as transparent housings to aircraft cockpits, as shown in *Fig.* 4. The transparent housing is held to the airplane structure by rivets or small machine screws and nuts. Under the vibration of the airplane and the wide temperature extremes, the plastic receives hard service. Located upon sliding panels it may be moved backward and forward to permit entrance of passengers.

Another trait of cellulose plastics, not often mentioned in literature, is the behavior of the materials toward temperature extremes. At high temperatures they may become soft and fail to maintain shape and dimensions; at low temperatures they become quite embrittled. The writer has seen sheets of cellulose acetate, flexible and shock resisting at room temperatures, shatter under the tap of a light hammer blow at zero temperatures. On measuring the physical characteristics a decided increase in tensile strength and loss in elongation were observed at freezing temperatures as compared to normal temperatures.

When high strength and the best structural characteristics are desired in plastic materials the designer invariably reverts to laminated plastics, canvas or linen weave types. Compared with the strengths of steels and duraluminums these materials suffer in comparison, unless specific tensile properties are compared (on a weight basis). While the usual linen and canvas laminated plastics have tensile strengths in the neighborhood of 10,000 pounds per square inch, strengths as high as 14,000 are obtained in canvas types. New developments in the parts of some plastic manufacturers have produced materials with thoroughly impregnated wood veneer laminations, having tensile strengths as high as 25,000 pounds per square inch, though this strength is much less across the grain. Likewise special grades of paper used in laminated plastic manufacture will give tensile strengths up to 20,000 pounds per square inch. At present, designers must satisfy themselves with high strength, canvas base materials. In general, there are two types of above-the-average high strength laminated plastics, referred to in the trade as balanced gear stock.

Recognizing that a great deal of the strength of laminated plastics is derived from a strongly woven

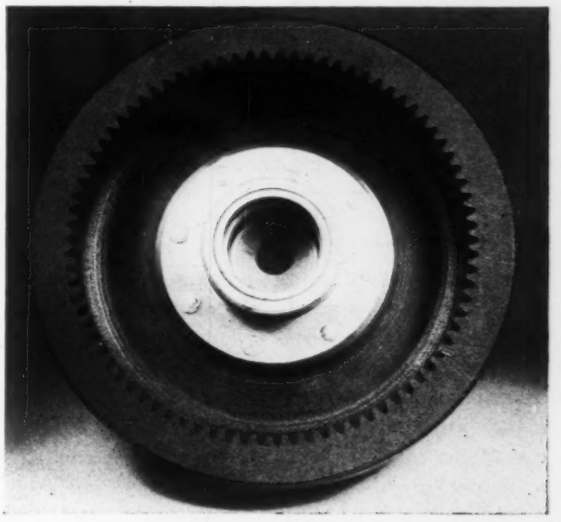


Fig. 5—Strength is obtained in a laminated plastic gear of this type by using strong canvas and running every other ply crosswise

textile base, enterprising plastic manufacturers have attempted to develop grades of textiles that would give them stronger products. Two of the typical weaves that have been developed to give these superior qualities are:

Balanced Weave Type—Warp and filler threads are placed under equal tension and a tightly woven canvas especially designed for laminated plastics is utilized. Balanced Gear Stock—Strength is obtained by using strong canvas made from strong warp

threads tightly laced with right size filler threads. Equal strength is obtained in both directions by running every other ply crosswise. An internal gear of this type of material is illustrated in *Fig.* 5.

In the manufacture of gears and bearings, laminated plastics are of incalculable value, and give long life under adverse conditions. To see large gears, pinions and bearings of laminated plastics in operation would convince one that they are equal if not superior under certain conditions to brass or steel. Loads considerably in excess of the safety factor have been carried without mishaps, in fact large roll neck bearings of laminated plastics in sheet mills carry tremendous loads.

Micarta propellers for airplanes were developed as early as 1918 and revived again recently when complete freedom from warpage was evidenced by the plastic material. In tumbling barrels where small metal parts are plated while being tossed helter-skelter laminated phenolics were chosen for their endurance and chemical resistance.

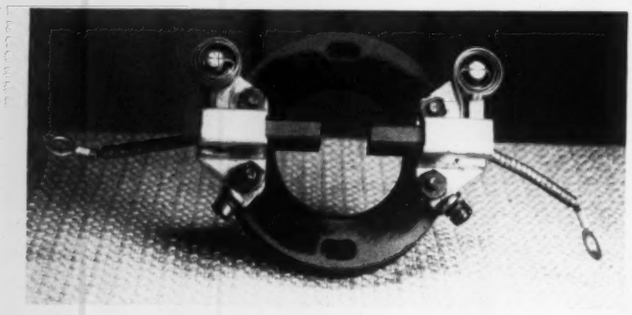


Fig. 6—Molded phenolic plastic brush holder ring serves not only as good support for holders but insulates them from other parts of motor

Aeronautical engineers, constantly in search of high-strength, low-weight materials, have considered plastic materials as a metal substitute. If compared directly with wood the future of plastics in airplane structures would appear bright. In certain aircraft designs large areas of thin laminated plastics have been specified for mounting instruments and miscellaneous aircraft accessories. Large diameter tubes of laminated canvas plastics are often applied with an attached bellmouth at the end for antenna air leads. In addition, control pulleys of molded and laminated, shock resisting phenolic plastics are standard upon all aircraft, as they are not affected by corrosive conditions. Plastics, however, do not approach duraluminum or steel in moduli of elasticity, and are not suited as well for aircraft structures.

Employment of laminated plastics for mechanical parts of electrical equipment has become such a standardized procedure, that no more than passing attention is given to this problem. When exceptional strength is required, laminated rods of phenolic plastic are used with solid metal core. Safe mounting of a switch terminal board or a group of connections to an electrical supply system is made possible only through the use of a material combining good electrical properties with high mechanical strength. *Fig.* 6 shows two die cast brush holders mounted upon a solid ring of molded phenolic plastic. In designing electrical terminals laminated plastic angles will often save the necessity for extra bushings and units. The trend from sheet or tubular laminated plastics to angles would simplify mechanical designs of insulation. Mechanical properties of laminated plastics are also displayed to good advantage by their application to cams, bushings and surfaces subject to the rubbing action of metal.

Other designs for which laminated or molded plastics may be used are those entailing a cylindrical housing of some description. Structurally, tubular sections of laminated plastics would be more suitable than molded parts. However, there is the question of finish and the continuity of the external design features. Moreover, the concentricity of the inside and outside diameters of laminated tubings is not always accurate and some provision may have to be made for grinding down the outside dimensions.

Laminated Plastics Used in Forming Operation

Large sections of semi-cured laminated plastics have been introduced into forming dies with particularly good results. Direct reference is made to fan blades and propellers, manufactured from laminated rather than molded plastics. The final products are stronger, with much higher impact strength. These features appear, for instance, in generously curved helmets for miners, constructed to withstand an impact of 40 foot-pounds. First inclination would be to mold this part, but the requisite strength and shape were attained by use of laminated plastics. The forming operation is a molding procedure on laminated plastics.

These forming operations may also be performed upon fibrous, semi-curved molding boards, opening up a new outlet for ingenious mechanical designs involving plastics. Hitherto, the molding of plastics has been rather limited in the size of the molded parts, being confined to small units. Today large radio cabinets, molded of phenolic and urea plastics are common.

One cannot help but be impressed by the versatility of plastics and the ease with which they adapt themselves to design problems. Though handicapped in the past by brittle materials with low strength, they now offer a more serious challenge by including materials with great impact strength in hot molding compositions.

Articles on plastics recently published in MACHINE DESIGN include, "Heater Has Molded Plastic Fans," Sept. 1936, P. 27. "Phenolic Plastics—Design's Latest Bearing Materials," Part I, Sept. 1936, P. 34; Part II, Oct. 1936, P. 35. "Plastics Tide Surges Swiftly Onward," Jan. 1937, P. 40. "Plastics Model Facilitates Telescope Design," June, 1937, P. 44. "Oilless Bushings Reduce Machine Maintenance," July, 1937, P. 42. "Plastics in Machines," Part I, Oct. 1937, P. 37; Part II, Nov. 1937, P. 46. "Designing Plastics from Standpoint of Production," Jan. 1938, P. 36.

IDEAS

Where Do They Come From?

By Paul Christiansen
Chief Engineer
Dow Pump and Diesel Engine Co.

WHERE do ideas emanate from? From within the individual or through the individual? From an inside source or from an outside mental world? Are they simply new patterns resulting from the shuffling about in the mind of an individual of old, inherited ideas or newly acquired ones, or are they like mental comets, appearing apparently from nowhere and being visible first to that observer whose attention happens to have been focussed upon a particular segment in the mental heavens? The observed fact that similar ideas so often do occur simultaneously to several people would seem to favor the latter view.

Sometimes great ideas, like periodic comets, have recurred at long intervals in human history. For example, the printing press, gunpowder, and the compass, were first discovered and used by the Chinese centuries ago.

While ideas seem more or less to pop into consciousness, a little closer study will usually prove that the individual had been doing at least a mild sort of concentration upon the subject related to the idea. If questioned, he would be apt to give the same answer Newton gave when asked how he discovered the law of gravitation, which was, "By constantly thinking about it."

Like most things in life, ideas do not just happen. Invariably they require a period of incubation quite like that of the egg under the hen. The process further simulates that of the hen by requiring a great deal of patience. However, when it comes to ideas, the period of incubation, unlike that of an egg, is most uncertain. In addition, there is always the possibility of an idea-egg proving to be of the unhatchable "china" variety.

Speaking of the annoying frequency with which identical ideas occur to several minds at the same time, let us consider a few instances. While Charles Darwin, great English naturalist, is generally credited with being the discoverer of the theory of evolution, there seems to be no question but that Alfred Russel Wallace, another great naturalist and sociologist of the same period, conceived the idea at the same time. Their joint essay on the subject of evolution was read at the annual meeting of the Linneaen Society in London in 1858.

Joseph Priestly, English philosopher and chemist, discovered oxygen in 1774. It was independently discovered by Wilhelm Scheele, Swedish chemist, at the same time. In mathematics we have Isaac Newton in England and Gottfried Wilhelm Leibniz in Germany simultaneously developing the principles of the differential calculus.

Credit May Go to the Fast Worker

One obvious difficulty in citing instances of this kind is that responsible scientists and other professional men are usually loath to tell the world of their discoveries or inventions until they have thoroughly verified the original idea. Often this may mean one or more years delay and in the meantime less conscientious workers may have stumbled upon, or perhaps even stolen, the idea and exploited it to their own personal glory. Also, whenever men of different nationalities are involved, national pride and prejudice tend to obscure the facts.

Another more recent case, not quite so clear, is that of Alexander Bell, inventor of the telephone, and Elisha Gray, outstanding electrical engineer and founder of the Western Electric Co. Both claimed to have conceived similar ideas and Gray is reported to have filed a caviat for the invention of a telephone on February 14, 1878, only two hours after the filing of Bell's patent. Twelve years later, after a long drawn-out court battle, the patent—an immensely

valuable one—was finally granted to Alexander Bell.

Ideas, as such, are not worth much. Undeveloped ideas can be picked up by the barrel any sunny afternoon in our city parks. People with ideas, sometimes good ones, are everywhere, but few there are who have the necessary ambition to develop them into things we want. Columbus may not have been the only man to conceive the idea of a new road

to the East Indies, but he was the only man who set out to find this road, and in his search by chance discovered a new world.

Again, the original inventor of the idea back of a revolutionary piece of machinery or process often has accomplished little or nothing himself towards making it practical. And so today his name is forgotten. Not so the man who took hold of the idea and developed it into a practical machine like, let us say, the typewriter. The world remembers such a man and willingly pays tribute to him.

James Watt, popular belief to the contrary, became famous not so much for the ideas he contributed as for the ideas he worked out. Robert Fulton was not the first man to experiment with steamboats, but rather was the inventor of the first successful steamboat. Like Watt, he took the crude models of previous and perhaps more original workers, and developed them into an efficient and practical appliance.

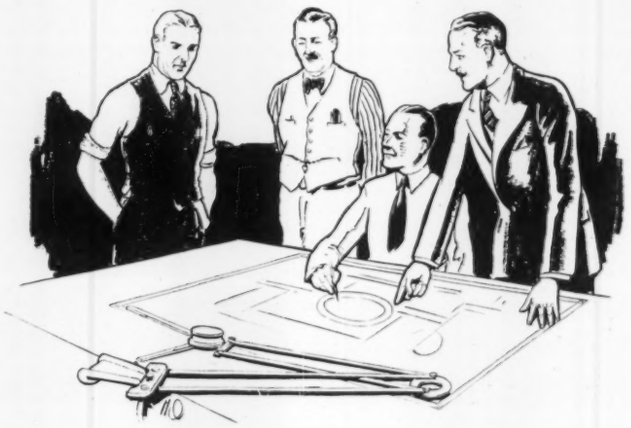
The same was decidedly true of Thomas A. Edison, whose saying along this line is worth quoting: "The first thing is to find out everything everybody else knows about a subject and begin where they leave off." If this advice were heeded by our inventors, most of them would have to quit inventing and go to work.

When it comes to evaluating ideas, the fact is that we generally are not much interested in other people's undeveloped ideas. We have too many brain children of our own to look after to adopt or to worry over those of others. Hence if a man comes to us with a brand new idea on television we will not be interested unless perchance we happen to be connected with the manufacture of such equipment. We want the idea worked out as a practical machine so that when we throw a switch the picture appears.

How far should we claim personal credit for creative ideas that come to us? The answer will largely depend upon our estimate of our own position and importance in the scheme of things. If we recall that this world of ours has existed, more or less civilized, for a good many thousand years, and that many millions of people quite as intelligent and observing as we consider ourselves to be, have lived and worked and struggled with similar problems, we will probably feel rather humble and avoid any rash and egotistical claim of originality. We will more likely be satisfied with quietly taking an imaginary place in the long, long line of workers, past and present, who have contributed to what we know and have accomplished.

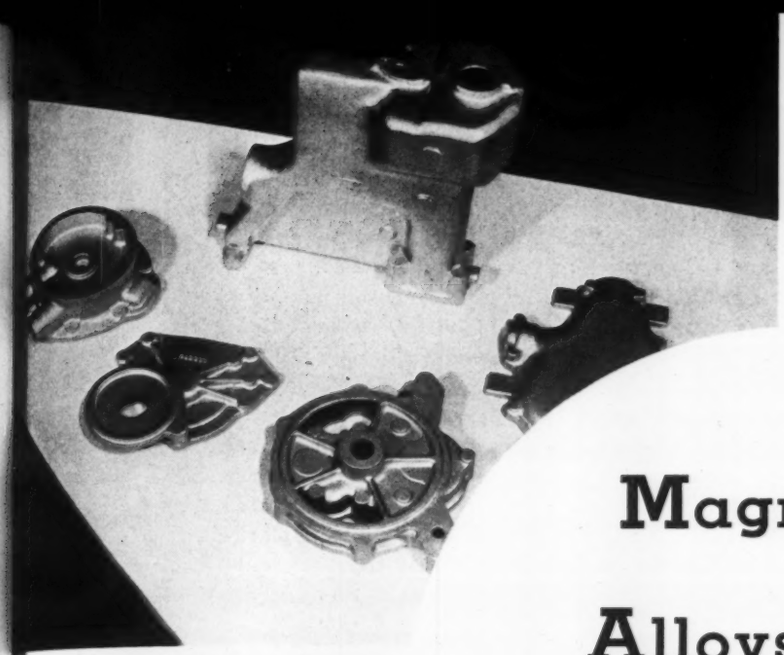
We frequently hear it said that there is nothing new under the sun, but we like to think that perhaps there are rare exceptions. But is it not safer to think of all idea material as universal and gratuitous and simply be appreciative of the fact that our receiving sets, to use a modern comparison, happened to be dialed exactly right for picking up the sought for message?

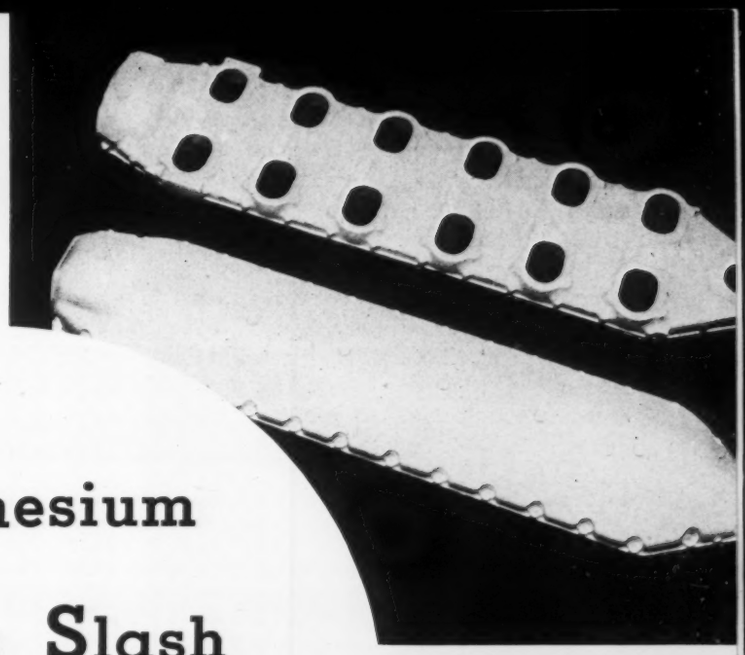
Some day we may be able to enjoy the pure idea without any need of materializing it into books, radios, machines, institutions or whatnot. Until then, why not let us encompass as many ideas as we feel we can assimilate and help to work them into tangible things that the rest of the world can use and enjoy. Let us reaffirm, at least to ourselves, that the law of supply and demand always works, and that where there is a demand for something, be it labor saving machinery,



a new poison gas, or a social security plan, somebody sooner or later will conceive or receive the idea.

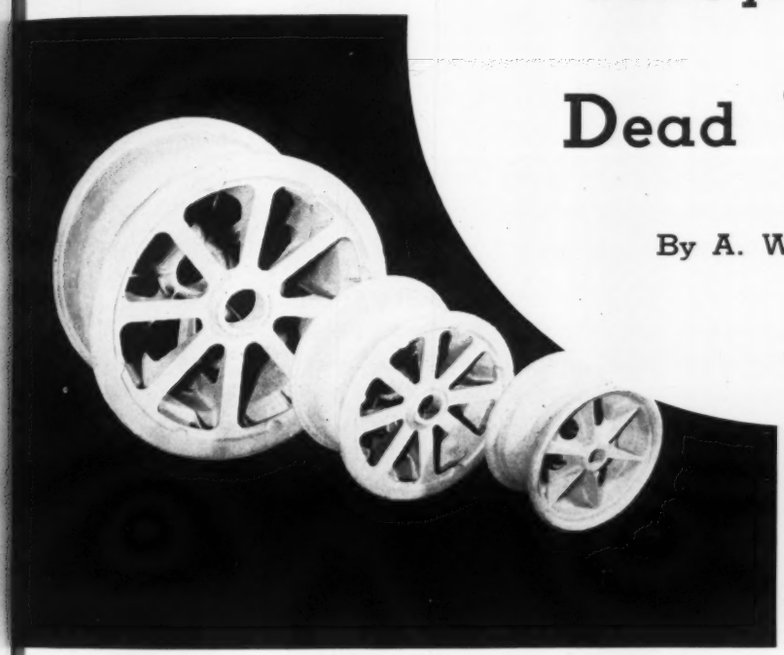
No doubt Plato would have enjoyed the story told by Emerson of how he loaned his copy of Plato's "Republic" to one of his Concord neighbors. When the neighbor brought back the book Emerson asked him how he liked it. "First rate," said the neighbor; "that fellow Plato has got a lot of my ideas."

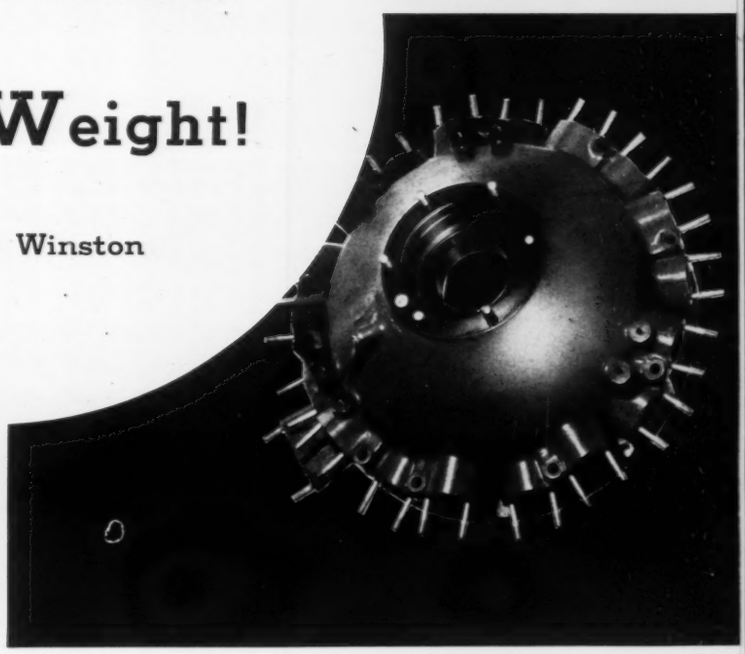




Magnesium Alloys Slash Dead Weight!

By A. W. Winston





ALLOYS of magnesium have made tremendous strides in recent years as satisfactory materials for machine parts where lightness is a prime requisite. Their greatest application is in aircraft where weight saving is a first consideration in design. In the accompanying article abstracted from a paper given at the Western Metals Congress many uses of magnesium alloys in airplanes are cited and their properties discussed. The author is with the Dow Chemical Co.

SAFETY, comfort and performance of the modern airplane are made possible largely through the availability of new light-weight, high-strength materials, among which magnesium alloys are occupying an increasingly prominent place. The outstanding characteristic of these alloys is their lightness, all of them having a specific gravity of less than 1.85. This is but two-thirds the weight of aluminum and less than one-quarter the weight of steel. Light weight is combined with good mechanical properties on a volume basis, resulting in the highest obtainable strength-weight ratios among comparable materials. Fabricated forms

Fig. 1—Pump casings and other intricate engine parts cast of magnesium alloys are shown in view at upper left. Upper right are sand cast magnesium alloy cam shaft cover and housing; lower right depicts a radial engine crankcase housing of this material. Great weight saving is accomplished in aircraft wheels, lower left, by utilizing magnesium alloys

include sand castings, die castings, forgings, extruded shapes and sheet, all of which are used in the construction of aircraft.

The successful application of magnesium alloys as structural materials has been due to the development of alloys specifically adapted to these fabrication processes. Principal alloying elements are aluminum, zinc and manganese, in varying amounts but never exceeding a total of 12 per cent. Many other elements alloy with magnesium but do not result in useful properties.

So successful is present day foundry practice for magnesium alloys that castings weighing more than 300 pounds are regularly produced. The majority of castings are, of course, much smaller than this. Aside from aircraft, the principal applications for castings have been in the construction of portable tools, packaging machinery, electric motor fans, motion picture cameras, foundry flasks, bread slicer frames, instruments, aerial cameras, safety blocks, and jigs and fixtures for production machinery in automobile plants.

Landing wheels and engine parts are the principal aircraft applications for magnesium alloy castings at the present time. Examples are shown in *Fig.* 1, lower left and lower right. When correctly designed, the performance of these wheels has been very satisfactory in all sizes. As military and transport planes have increased in size, the weight savings obtained through the use of magnesium wheels have become increasingly significant. Magnesium alloy wheels have been used successfully in Europe for years, both on the Continent and in England where rough castings up to 200 pounds in weight are not uncommon. A pair of these wheels would result in a weight saving of at least 150 pounds or the equivalent of an additional passenger.

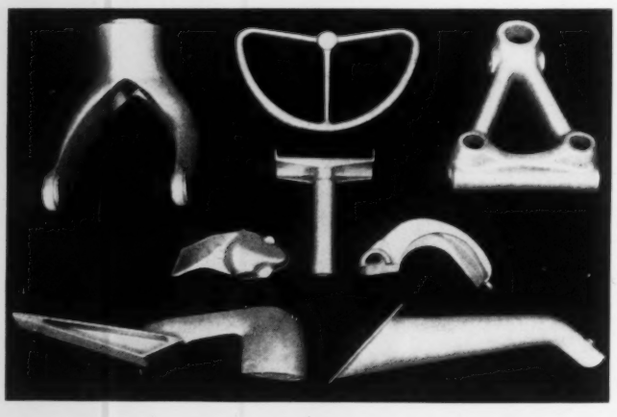


Fig. 2—Control wheels and levers, tail forks, pedals and similar structures are cast of magnesium alloy and serve adequately to carry the load

In engines, magnesium castings are used for such parts as accessory cases, blower sections, thrust bearing housings, rear sections, diffuser plates, oil pumps, pump bodies, camshaft housings, air ducts, and for miscellaneous small parts and covers of all kinds. A number of these are shown in *Fig* 1, upper left and upper right. All of the larger engines, both radial and in-line, have parts made of magnesium alloy castings. The low weight per horsepower of the modern high-output engine would be impossible without the use of magnesium. In general, the service performance of the material has been good. The few failures which have been experienced usually have been traceable to design. With increasing concentration of power necessitating high-strength steel for the greatly stressed portions of the engine, it is expected that magnesium alloys will find even wider application in accessory parts.

Structures Made of Magnesium Alloys

Magnesium alloy castings are used to some extent also in airplane structures. Parts in use at the present time are control wheels and levers, tail forks, door frames, air scoops, control housings, pedals and many miscellaneous brackets and supports. A few of these are shown in *Figs.* 2 and 3.

Permanent mold casting or high pressure die casting should be given consideration when the number of pieces to be made is large enough to warrant the expense of the dies. A considerable number of airplane wheels have been made by semi-permanent mold casting, using sand cores in steel dies. Die casting has been satisfactory in the production of various engine parts, including rocker box covers and shroud tube fittings. Widespread application of these methods, however, will come only with a large expansion of the aircraft industry as a whole.

The use of wrought magnesium alloys has been developing rather slowly, perhaps because these materials have become easily available only recently. At the present time, it is possible to obtain extruded structural sections in all forms, such as angles, channels, I-beams, tubing and bars. Extruded magnesium alloys are incorporated in much of the furniture and secondary structures of European aircraft. While the logical procedure will be to introduce these materials into aircraft by way of lightly stressed parts, there are indications that extruded members eventually may be used in primary structures. For example, the main spars of the 12-engined flying-boat, the Do-X, were made of extruded magnesium alloy.

Magnesium Sheet for Fuel Tanks

Magnesium alloy sheet is used extensively abroad in the construction of aircraft fuel and oil tanks and for furniture, cowling and fairings. These same uses are being developed experimentally in this country but are not yet in widespread commercial production. Any possibility of corrosion in gasoline tanks is eliminated through the use of a cartridge containing inhibitive salts which is placed in the pump at the low-

est point of the tank.

Forgings comprise another class of wrought magnesium alloys. They may be either hammer forgings or press forgings. The best properties are obtained in press forgings and these should be used whenever possible. Forgings are not yet used extensively in aircraft construction, although some engine parts have proved very satisfactory.

The most interesting application for magnesium alloy forgings is for propeller blades. Experimental propellers made several years ago did not possess the required properties. The subject was not forgotten, however, and recent work has yielded some encouraging results. In Europe, where more adequate press forging equipment is available, magnesium alloy propellers are being used with conspicuous success. For example, twenty-six of the thirty-four entries in the 1934 European Air Derby used magnesium alloy propellers, including the first six to finish.

As with most structural materials, care taken in the small details of working and finishing is essential in the successful application of magnesium alloys. These alloys are the easiest of all structural metals to machine. Usually the speed of machining is limited only by that of the available equipment. The ordinary operations are performed dry, a coolant being used only on very high-speed screw machine work producing fine shavings or where it is necessary to maintain very precise measurements on large dimensions.

Riveting Best Method of Joining Assemblies

The forming of magnesium alloy sheet and shapes can best be done at a temperature of 500-700 degrees Fahr. due to a tendency of the material to harden rather rapidly with cold working. A limited amount of cold working is possible but liberal bend radii should be allowed. Generally speaking, the use of heated tools and dies will permit the forming of parts.

Riveting is the recommended method for the joining of structural assemblies. The design of riveted joints in magnesium alloys is based on the shearing strength of the rivet material and on the tensile and bearing strengths of the sheet. The bearing strength of sheet may be taken as 60,000 pounds per square inch, about 50 per cent greater than the tensile strength.

The use of magnesium alloys in the construction of fuel and oil tanks is made possible through the oxy-acetylene welding process for this material. Welds should never be attempted between magnesium alloys and those based on other metals, such as aluminum, brass, or zinc, due to the formation of brittle intermetallic compounds. Great care must be exercised in the welding operation not to include flux in the weld metal, as any traces of flux will promote subsequent corrosion.

Contrary to earlier conceptions, magnesium alloys

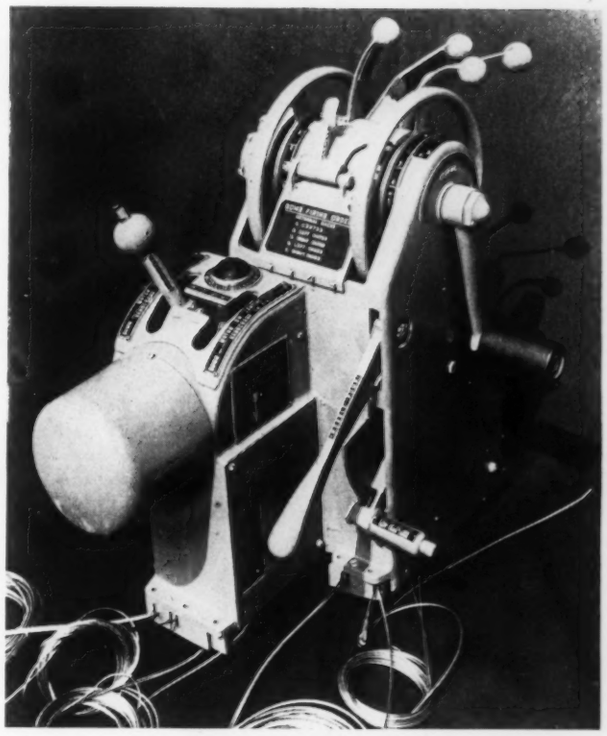


Fig. 3—Neat and light, the entire control housing of twin motored bomber is made up of castings of magnesium alloy

are quite stable under ordinary conditions of weathering. A buffed or polished surface will gradually tarnish, but roughening or powdering will only take place in heavy industrial areas or in locations of continuous high humidity. In salt atmospheres corrosion may be more active and necessitate some form of protection. The material is not recommended for applications involving direct contact with water or aqueous salt solutions. Because of the difficulty of controlling exposure conditions, some form of paint protection should always be applied after the surface has been given a chemical treatment.

In building assemblies from magnesium alloys which will be exposed to the weather, care should be taken to avoid pockets which might entrap water and ultimately cause corrosion to take place. Enclosed areas should be given at least one coat of primer and should either be made absolutely watertight or provided with adequate drainage and good ventilation.

When magnesium alloy parts have been carefully chemically treated and painted, they have given satisfactory performance, not only inland, but along the sea coast as well. The logical procedure in the application of magnesium alloys to aircraft would seem to be to take advantage of the weight saving possibilities as far as is consistent with economy and safety. It is believed that there is a real place for magnesium alloys and that their use after a serious study by engineers and builders will result in increased payloads and improved performance.

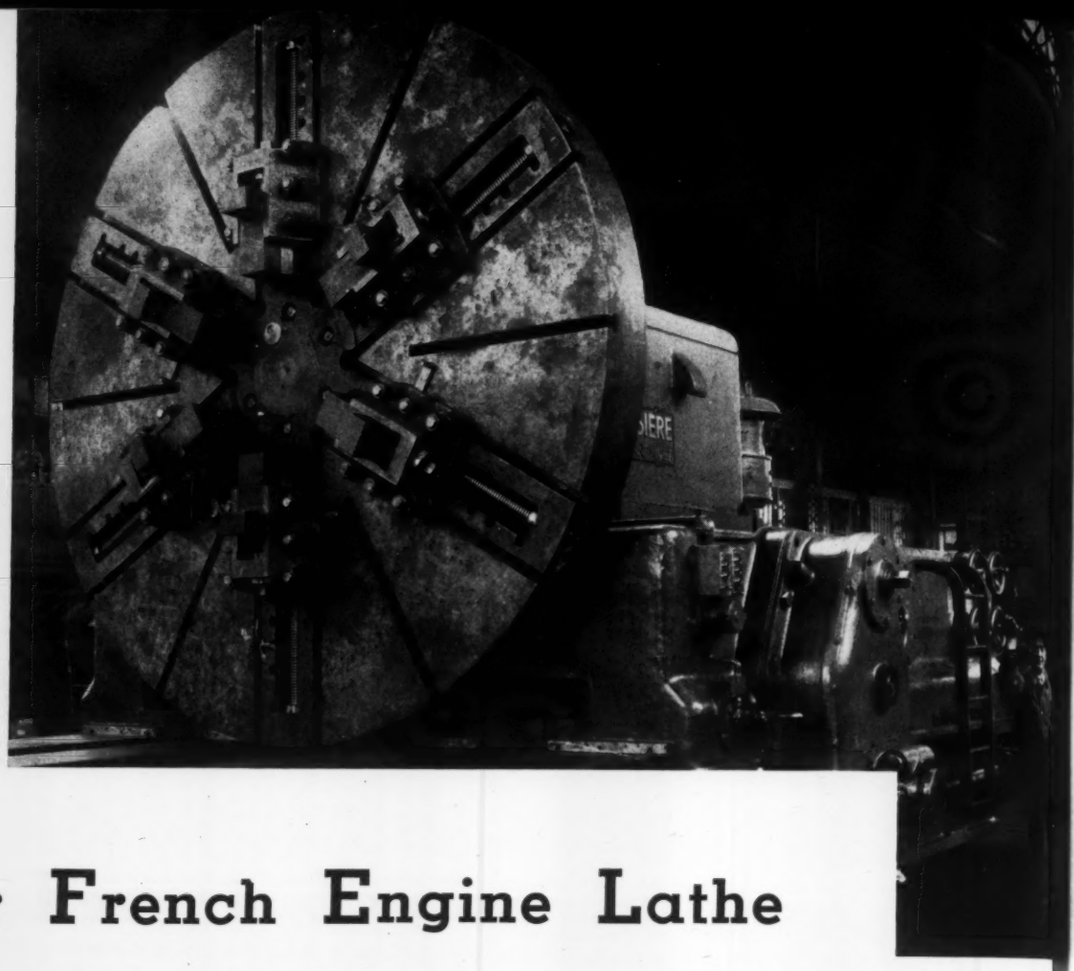


Fig. 1—Operator at the headstock controls of 273-ton lathe of 10-foot swing, recently designed and built in France. These controls, located at back of motorized headstock, include a heavy-duty, multi - push - button station

Monster French Engine Lathe Shows Advanced Ideas

By Alfred Wasbauer

UNQUESTIONABLY the lathe holds first rank among machine tools, there being numberless machining operations where it is indispensable. Its principle seems to have been understood in the most remote antiquity, when artisans used it — in the form of the potter's wheel — to fashion their vases and other potteries. As such it was used 2000 years before our era. It certainly was well known among the Greeks, who may possibly have used some adaptation of it to shape stone columns, and Pliney wrote of its utility 600 years before Christ.

Primitive forms of the lathe — other than the potter's wheel — include the bow drill and the bow-driven lathe (still in use not only by the Eskimos and other primitive people, but also by workmen by no means so primitive, as for instance in the Black Forest of Germany.) A development from the bow lathe, for handling larger, heavier work, was the pole lathe driven by an overhead spring pole from which a cord passed around the work to a foot-power treadle hinged to the floor. As a boy the late John M. Browning, noted inventor of repeating and automatic fire arms, turned out work on a pole lathe of which the overhead spring was the branch of a living tree.

The basic principles of the tool carrying power driven slide rest, and of the change-gear operated, lead screw-controlled, thread cutting was developed in 1797 in the shop of Joseph Bramah by the famous English engineer Henry Maudslay, who about the year 1800 evolved the engine lathe essentially as we have come to know it today. Out of this, about 1850, evolved the turret lathe of Henry D. Stone, Frederick W. Howe and Richard S. Lawrence, which in turn led to the invention of the single spindle automatic by Christopher M. Spencer in 1873, and of the multiple spindle automatic by E. C. Henn and R. Hakewessel in 1893.

In the meantime other inventors too numerous to mention, in Great Britain, in Europe and in America, carried on the development of the true engine lathe, the development of which incidentally is still going on apace the world over.

Maudslay, whose engine lathe of 1800 was in the

nature of a little bench lathe of precision far ahead of its time, might have difficulty in recognizing some of his basic ideas which are as a matter of fact incorporated into the design of the monster heavy-duty lathe illustrated by *Figs.* 1 and 2 and described herewith. This huge machine, which was designed and built during the past year by the establishment of Chaleassiere, St. Etienne, France, is an interesting example of what European machine tool builders are doing today to meet production demands of the heavy industries.

Specifications Are Impressive

This lathe, which measures 66 feet between centers and 61 inches from surface of bed to spindle centerline, swings face plates approximately 10 feet in diameter. Weight, exclusive of electrical equipment, is 273 tons. American machine tool builders will be particularly interested in the following facts. The main drive motor, which is of reversible, variable speed type giving range of spindle speeds from 540 to 1000 revolutions per minute, is rated at 100 horsepower. There are four tool slides, each with sixteen independent power feeds and rapid traverse. Permissible load between centers is 100 tons and with four tools operating in steel of 80,000 pounds tensile strength, approximately one ton of chips per hour can be removed.

For deep drilling and boring such as that involved in large gun work, the conventional dead center tailstock is replaced by a revolving spindle boring stock equipped with its own 20-horsepower motor—this boring stock being shown in position in *Fig.* 2. Taper turning to the full useful length of the lathe is accomplished by combining longitudinal and transverse feeds, long taper threading being done in the same manner. On account of the great size of the machine, provision is made for an operator to "ride along with each of the tools"—as indicated by the railed platforms on the tool carriages in *Fig.* 2.

The bed which is of perlitic cast iron of over 200 Brinell hardness, has four flat ways for the tool carriages. The bed can be considered as "double tracked", two of the tool carriages traveling on the two front ways and the other two traveling on the two rear ways. Each pair of carriages has its own independent "feed works", as is apparent in *Fig.* 2. The ways are part of rectangular beam sections formed by six vertical walls tied together by cross-ribbing. This construction gives to the whole a moment of inertia demonstrably constant with reference to the natural horizontal plane, lending maximum rigidity to the ways. The bed is normalized before its final machining and assembly to insure preservation of its geometrical accuracy.

Handwheel Controls Spindle Speed

All the main drive elements are contained in the oil-tight spindle housing, and all spindle speeds are controlled by a single hand wheel. It is practically impossible for an operator to make a destructive false move, the same safety principle being true of the feed changes. Pushbutton control of any movement of the lathe elements is possible from any one of the four tool carriages, one of these multi-push button stations can be seen at the right of the forward tool carriage in *Fig.* 2.

Lubrication of the main drive elements is by oil delivered under pressure by the independently motor-driven pump which can be seen plainly at the rear of the spindle housing in *Fig.* 1. Accessory shafts and gears are gravity-lubricated by oil from a reservoir supplied by still another pump. Visual gages and manometers verify lubricant flow.

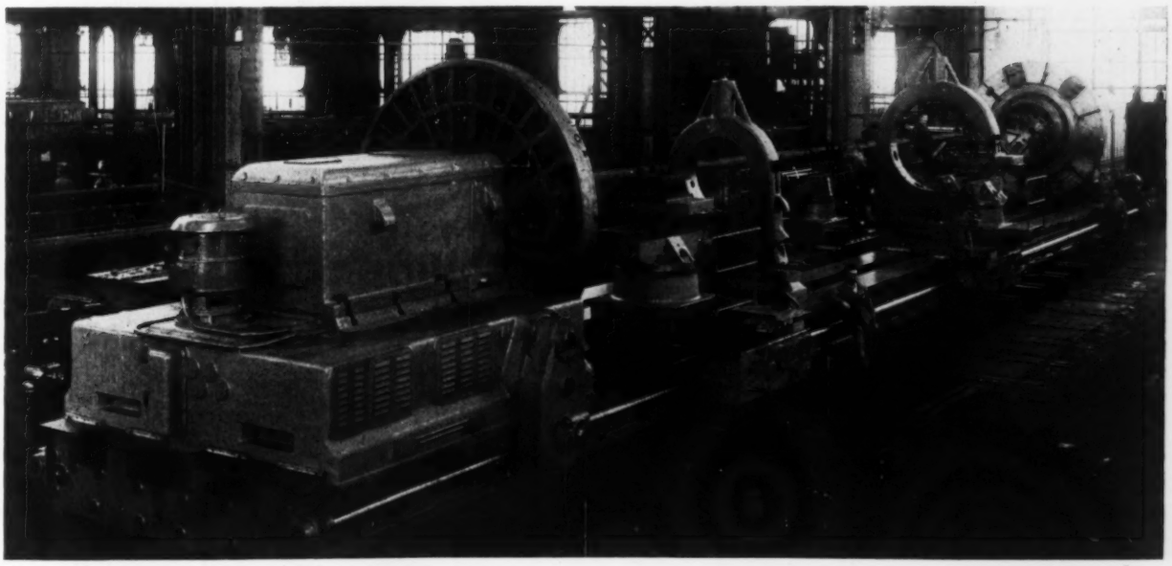
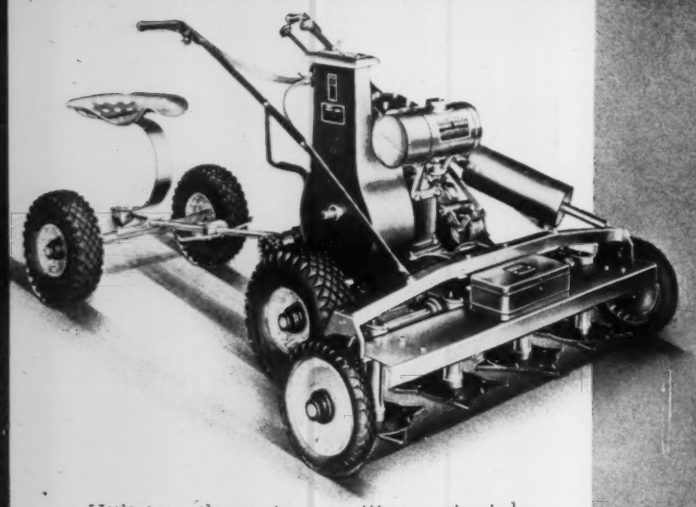


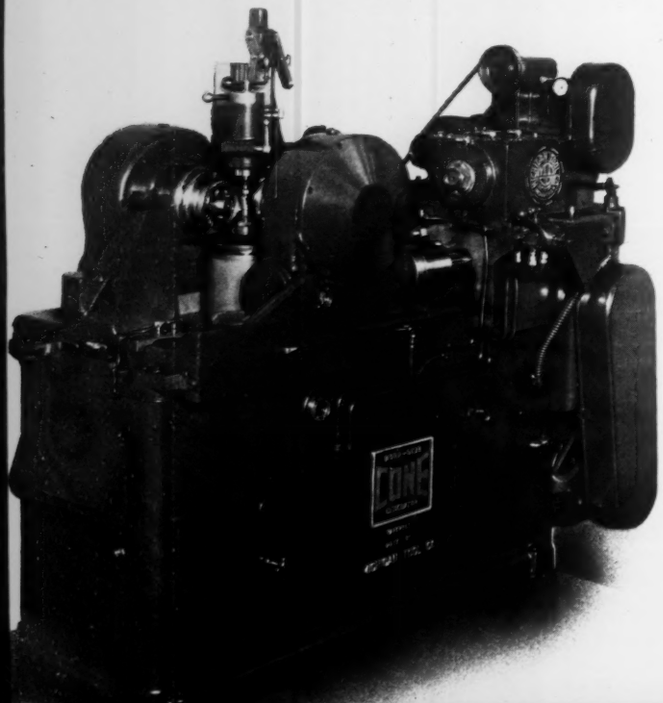
Fig. 2—Front view of big French lathe from headstock end, showing power-driven boring stock in position at tailstock end. Note that two of the four-tool carriages operate from rear of "double-tracked" bed



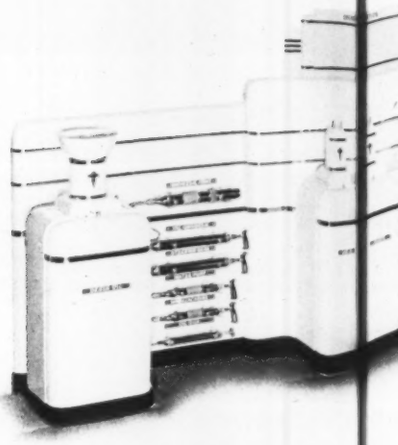
Utilizing the rotary cutting principle, the power-driven Standard lawn mower, above, is of all-welded construction. Engine is four cycle, equipped with gas and air cleaners. Simple belt and idler type of drive is used, operating through a transmission and differential

Vertical construction is unique feature of Zephyr coffee mill, right. Small base and the centralizing of switch, nozzle and grind regulator are advantages of this design. Adjustment of the grind notches illuminates a panel facing the customer and indicates grade to which coffee is being ground

Centralized, automatic lubrication insures long life and trouble free operation of the Michigan automatic cone gear generator, below. Work is held in the spindle by a spring set collet chuck, released by a double-acting air cylinder. Machine is quite flexible as quick change gears for cam drive vary rate of feed; other change gears control machine speed



Comprising a group of a…atic dispensing lubricants, the …coln below, delivers grease and …at pr… 5000 pounds per square inc… Simp… to facilitate cleaning and t…ke t… many in…tions



Design Fe…
In New Ma…

A Pictorial Presentation of Re…
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Variable speed drive on Delta scroll saw, above, gives speed range from 650 to 1700 RPM. Air pump for blowing shavings from around work is driven directly from crankshaft and not from upper plunger, avoiding load on delicate blade. Weight of moving plunger parts is exceptionally low, yet obtained with little sacrifice of strength

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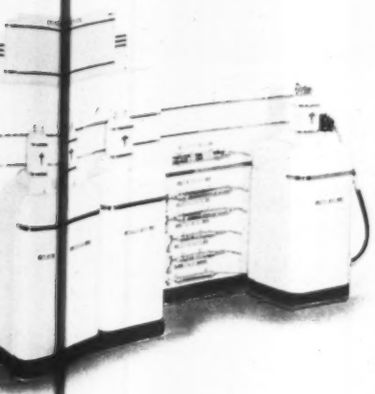

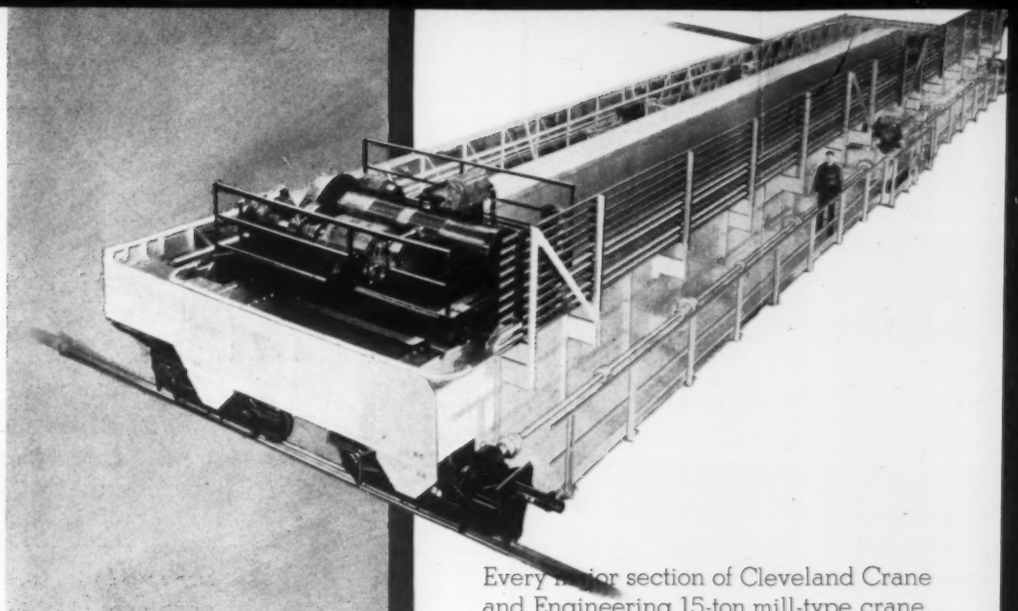

Every major section of Cleveland Crane and Engineering 15-ton mill-type crane, above, such as two main girders, four end trucks, cage, etc. are fabricated into one rigid unit by electric welding. Hoist is provided with 100 horsepower motor. Complete crane weighs 275,000 pounds

Features
Machines

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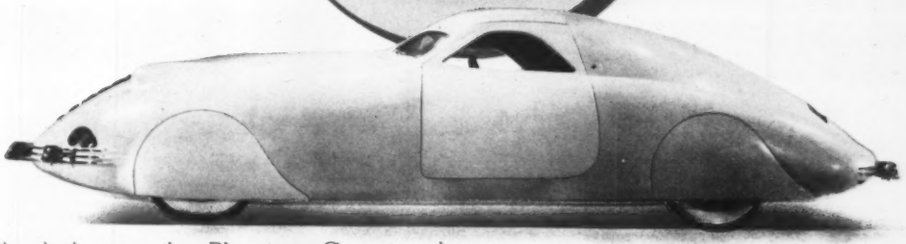
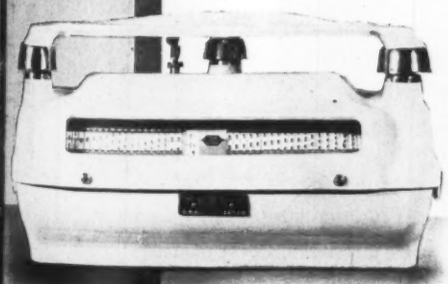
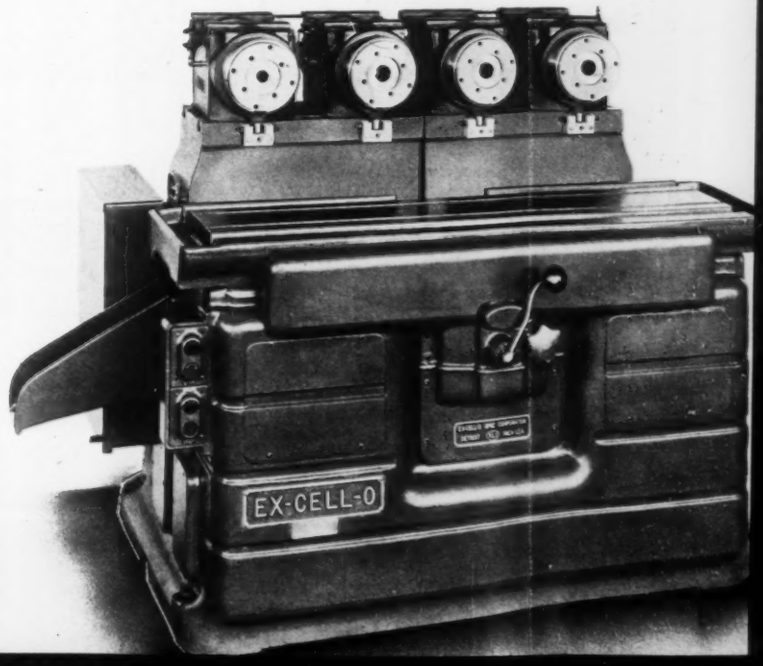


Of radical design, the Phantom Corsair, above, designed by Rust Heinz, reaches the superlative of streamline construction. Doors open by touching electric buttons, bumpers have recoil spring action and aircraft-type alloy steel tubing is used for body framework. To facilitate entering the auto, auxiliary doors are provided in the roof which open automatically with conventional doors

Large number of spindle combinations are possible with the improved Ex-Cell-O facing and grooving machine, below, as provision is made for mounting driving motors above, beside or below the spindles, thus permitting a large number of spindle combinations. Work table traverse is operated by a hydraulic cylinder



All parts of the Ralston counter scale-above, are enclosed in a sealed two, piece porcelain enameled housing. Agate bearings are used in special tool pivots to give frictionless movement. Convenient location of computing chart enables it to be read easily from either side



New Machines Indicate Design Trends

THE successful manufacturer of a machine for transportation, whether it be an auto, motorcoach, streamlined train, boat or airplane, must give more than casual attention to insulation. He must build a machine that is insulated against sound, heat and grounding or short-circuiting of electrical connections. Physical and mental comfort of passengers depends upon maintenance of temperatures between 60 and 80 degrees Fahr. and the prevention of noise absorption within the vehicle body. Safety demands machines which are adequately insulated against electrical discharges. This last requirement is usually met by proper wiring and electrical controls. Today many materials are on the market to accomplish the first two insulation needs. For sound insulation there are rubber, felted fibers impregnated with plastic material and fibrous board. For sound and heat insulation there are glass wool, rock or mineral wool, fibrous felt of jute, hair, cotton or wood fibers. To obtain proper heat insulation against high temperatures, a combination of aluminum foil cemented on a noncombustible board is ideal. Proper materials are available for any insulation requirement and the designer of transportation machines should investigate them thoroughly.

Air Conditioning

Home and store air conditioning units, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Air conditioning unit, Delco-Frigidaire Conditioning Div., Dayton,O.
"Fan" table, Kisco Co. Inc., St. Louis.
Exhaust fan, Chelsa Fan & Blower Co. Inc., New York.

Automotive

*Six passenger coupe, Rust Heinz, Los Angeles, Calif.

Business

*Coffee mill, Hussman-Ligonier Co., St. Louis.
*Counter scale, Ralston Scales Corp., Columbus, O.

Dairy

Pasteurizer, Crouch Process Equipment Co., Chicago.

Domestic

Electric plant, D. W. Onan & Sons, Minneapolis.
Stoker, Holcomb & Hoke Mfg. Co., Indianapolis.
Electric furnace cleaner, Carl E. Swift Corp., Holland, Mich.
*Power lawn mower, Standard Mfg. & Sales Corp., Lebanon, Ind.

Foundry

Speedmullor, Beardsley & Piper Co., Chicago.

Industrial

Automatic riveter, Chicago Rivet & Machine Co., Chicago.
Electric screw drivers, Stanley Electric Tool Div., New Britain, Conn.
Mixer, Patterson Foundry & Machine Co., East Liverpool, O.
Automatic finishing machine, Spray Engineering Co., Somerville, Mass.
Oil-fired heater, Despatch Oven Co., Minneapolis, Minn.
Motor-driven wire stripper, Ideal Commutator Dresser Co., Sycamore, Ill.

Lubricating

*Lubricating unit, Lincoln Engineering Co., St. Louis.

Materials Handling

Portable electric hoist, Shaw-Box Crane & Hoist Div., Muskegon, Mich.
Scale truck, Barrett-Cravens Co., Chicago.
Portable electric lifter, Service Caster & Truck Co., Albion, Mich.
Ram and fork tractor, Automatic Transportation Co., Chicago.
*All-welded crane, Cleveland Crane & Engineering Co., Wickliffe, O.

Metalworking

Portable electric drills and shears, Black & Decker Mfg. Co., Towson, Md.
Lathe, Sebastian Lathe Co., Cincinnati.
Portable boring bar, Van Norman Machine Tool Co., Springfield, Mass.
Carbide tool grinder, Baldor Electric Co., St. Louis, Mo.
Square shear, Northill Co., Los Angeles.
Automatic bending machine, Wallace Supplies Mfg. Co., Chicago.
Angle head for drilling, filing and grinding, Stow Mfg. Co. Inc., Binghamton, N. Y.
*Precision facing machine, Ex-Cell-O Corp., Detroit.
*Automatic Gear generators, Michigan Tool Co., Detroit.

Plastics

Light duty plastic molding press, Greenerd Arbor Press, Nashua, N. H.

Printing

Oiling and wiping machine, Chas. Wagner Litho Machinery Co., Niles, Mich.

Quarry

Concrete and rock drilling machine, Ingersoll-Rand Co., Phillipsburg, N. J.

Sound

Loud speaker for address systems, Bell Sound Systems Inc., Columbus, O.

Welding

Diesel engine driven arc welder, Lincoln Electric Co., Cleveland.
Spot welder, Eisler Engineering Co., Newark, N. J.
Electric arc welder, Harnischfeger Corp., Milwaukee.
Wide range arc welders, Hobart Bros. Co., Troy, O.

Woodworking

Floor sanding machine, Porter-Cable Machine Co., Syracuse, N. Y.
Portable electric saw, Skilsaw Inc., Chicago.
*Scroll saw, Delta Mfg. Co., Milwaukee.

*Description and photograph of this machine included in pictorial center spread.

Current Conditions Thrust Greater Load on Designers of Machines

AGAIN the designer takes the load! More and more is the development of new products playing a key role in the life of machinery building companies. With their backs to the wall due to the recession these organizations are battling valiantly to introduce new lines that will keep them going until the "fear" complex is alleviated and buying resumed.

Reports of numerous companies—now often being presented just as openly to employes as formerly was the case only at meetings of shareholders or directors—indicate clearly that successful attempts have been and are being made to develop new parts, new machines. The president of one company typical of many last month reported that more than eighty per cent of the company's income in 1937 was derived from products developed since 1932.

It is only by the birth of new items in this way that the slack can be taken up, unemployment reduced and in some instances, entire new industries brought into existence. A case in point is air conditioning. From small beginnings this has grown until it is no longer looked upon as a luxury, and is going ahead by leaps and bounds. Air conditioning holds possibilities as great even as the automobile business did thirty or forty years ago, being credited recently with providing a potential demand for direct and indirect labor running as high as five million jobs.

Meanwhile, alert manufacturers of many other types of machinery and parts are asking themselves—as pointed out in a paper on management presented at the recent American Gear Manufacturers' annual meeting: What new products can be developed by us; whether additions to the existing sales force would be necessary for marketing; the initial promotional expense that would be involved; whether manufacturing facilities are adequate; and other questions coincident with the development and handling of new products.

Design, production, sales are all involved in these questions. But the basic responsibility falls on the designer. That's the reason design staffs are not being trimmed down in proportion to others at this time—and that's the reason any designer with a bright, marketable idea may well prove to be "worth his weight in gold" to the manufacturer desperately seeking a comeback in sales volume.

Professional Viewpoints

MACHINE DESIGN WELCOMES LETTERS SUITABLE FOR PUBLICATION

Correspondent Approves of Patent Bill

To the Editor:

I NOTICE that a letter writer in your April issue takes a rather decided stand against the proposed patent bill which would provide compulsory licensing of patents three years after they are granted.

I have heard a number of objections to this bill, but they come almost entirely from patent attorneys and executives of large corporations and very few from actual inventors. Inasmuch as the majority of inventors die in the poorhouse it does not seem reasonable that the new bill will work a great hardship on them and may possibly prove a boon.

Certainly the compulsory licensing of patents after three years will prevent any individual or company from having a monopoly on a design or process for 17 years, during which period they may charge the public an exorbitant price for the product as is now done in hundreds of cases. This probably explains why corporation heads are opposed to the new law.

As for stifling progress, as was mentioned in the letter, it seems to me that the prevention of monopoly will do much to further technical progress as well as to bring the prices of many products to a level which a greater public can afford.

—FRED CHARTERS
New York City

Careful Handling of Employe Ideas

To the Editor:

TWO major problems arise in dealing with design ideas of employes. First is the economical and efficient separation of the wheat from the chaff, and the second is the disposing of ideas advanced which show little or no promise without hurting the feelings of the man who suggested them.

Ideas should be examined initially by some one individual whose mind is not heavily burdened with other affairs. This man should of course be an engineer, but he should be one with a heavy shop slant, if at all possible. Otherwise, he can do justice neither to the company nor the employe. Moreover, he must be a diplomat and a man with a personality, who can go into a proposed idea or design carefully with the man who advanced it, and fully convince the would-be inventor it is not suitable or advantageous.

—J. E. H.
Peoria, Ill.

Chart Simplifies Gear Calculations

To the Editor:

THE accompanying alignment chart (on next page) for the determination of the horsepower transmitted by spur gears was developed to enable the designer to solve problems of this character with speed and precision. It is believed this chart presents an advance over similar charts in that the scales are more advantageously placed and only the five variables involved as pertinent data are included.

The reduced equation for horsepower is

$$H.P. = 120\,\frac{N(0.124T - 0.684)}{(600 + V)P^2}$$

in which

$H.P.$ = horsepower transmitted per inch of tooth face width
N = number of revolutions per minute
T = number of teeth
V = pitch line velocity in feet per minute
P = diametral pitch

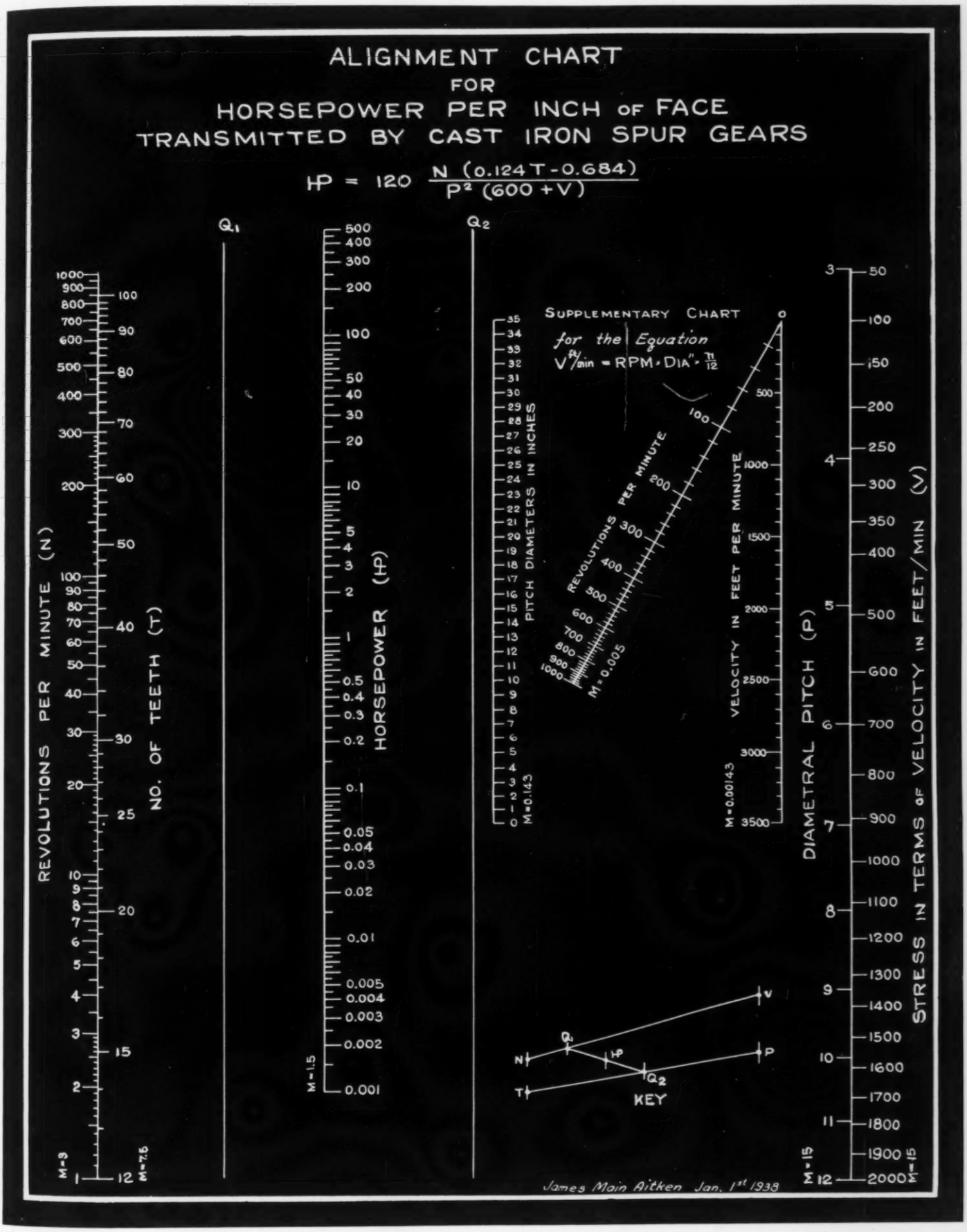
Other factors involved in the deduction include: W = thrust computed at pitch line in pounds; S_s = allowable static unit stress for cast iron (8000 pounds per square inch); S = allowable unit stress for material at given velocity = $S_s \times V_f$; V_f = velocity factor = $600/600 + V$ (when V does not exceed 2000 feet per minute); Y = strength factor due to tooth shape = $0.124 - 0.684/T$ for 14½ degree involute.

Making the face width factor equal to unity is, of course, a device approved by precedence. To find the face width becomes a simple matter of mental arithmetic, a turning scale has been eliminated and the function of the chart is in no way impaired.

The ambiguity of the scale title "stress in terms of velocity in feet per minute" is pardonable in that it is neither the one nor the other, but an incorporation of the two factors.

If the material is other than cast iron, a multiplier of 25 is used for steel castings; 3 for steel forgings; or 1.4 for bronze castings. The solution of the chart is for machine-cut teeth and highest class workmanship, and should be reduced to 75 per cent for ordinary workmanship.

—JAMES M. AITKEN
Belmont, Mass.


ALIGNMENT CHART
FOR
HORSEPOWER PER INCH OF FACE
TRANSMITTED BY CAST IRON SPUR GEARS
$HP = 120 \frac{N(0.124T - 0.684)}{P^2(600 + V)}$
Q_1
Q_2
REVOLUTIONS PER MINUTE (N)
NO. OF TEETH (T)
HORSEPOWER (HP)
M-3
M-7.5
M-1.5
SUPPLEMENTARY CHART
for the Equation
$V_{ft/min} = RPM \cdot DIA'' \cdot \frac{\pi}{12}$
PITCH DIAMETERS IN INCHES
M=0.143
REVOLUTIONS PER MINUTE
M=0.005
VELOCITY IN FEET PER MINUTE
M=0.00143
DIAMETRAL PITCH (P)
M-15
STRESS IN TERMS OF VELOCITY IN FEET/MIN (V)
M-15
KEY
N
T
Q_1
HP
Q_2
V
P
James Main Aitken Jan. 1st 1938

Men of Machines

IN VIEW of his long and varied experience in the engineering field, Joseph C. Lang is particularly well fitted to the requirements of his new position as chief engineer of Brooke L. Jarrett & Co., Pittsburgh, industrial engineers, specializing in the development of new products for industry. This company has developed such diversified products as automatic phonographs, automatic typewriters and oil purifiers.

Before his present appointment, Mr. Lang was associated with Automatic Business Machines Inc., Pittsburgh, as works manager. His earlier connections were that of designing engineer with National Cash Register Co., Dayton, O., and later in the same capacity with Dalton Division of Remington Rand Inc., Norwood, O. He was also one of the organizers of the consulting engineering firm, Brulan Engineering Co., Cincinnati.

JOSEPH C. LANG

• • •

APPOINTMENT of John C. Sharp as chief engineer of Edison General Electric Appliance Co. Inc., Chicago, has been made. Mr. Sharp, formerly head of the range engineering division, succeeds Charles P. Randolph, deceased.

Born in Cadiz, O., in 1900, he received his early education in Cadiz schools, later attending U. S. Naval academy for a year, and graduating from Ohio State university with a mechanical engineering degree. Before joining Edison General Electric he was with Weirton Steel Co.; Experimental Station, University of Illinois; Continental Rubber Co.; Standard Oil Co. as engineer in the technical division; and for brief periods was in coal mining, automotive and machine shops. In 1925 he became assistant engineer, range engineering division, Edison General Electric, and a year later its head.

JOHN C. SHARP

• • •

WELL known to the industry as a designer of engines, A. F. Milbrath, chief engineer of the company since 1909, has recently been elected director and vice president of the Wisconsin Motor Corp., West Allis, Wis.

Mr. Milbrath started his engineering career with the former C. J. Smith & Sons Co., now the A. O. Smith Corp., and after two years, became chief engineer. While here, he is said to have designed the first presses used for the manufacture of pressed steel automobile frames in the country. He is also credited with the design of all the Wisconsin Motor Corporation's gasoline engines, as well as the company's racing engines, which in 1915, when competing against racing cars of Europe and America, finished first and second at the speed of 106 miles per hour. The Wisconsin engine, which was first to attain a speed of three miles a min-

A. C. MILBRATH

PERFORMANCE SUSTAINED...

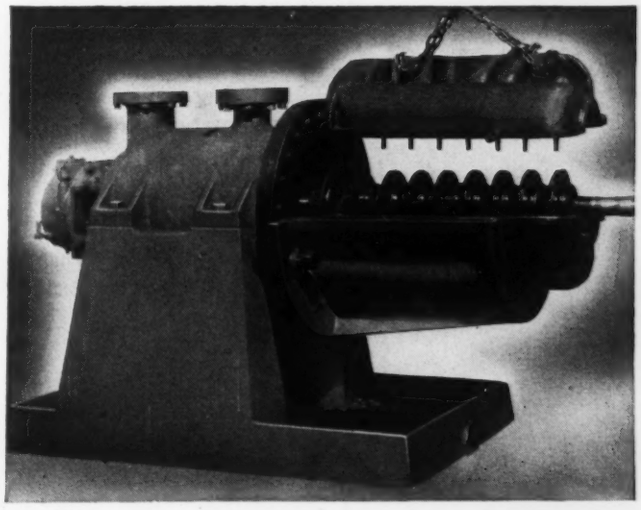
with

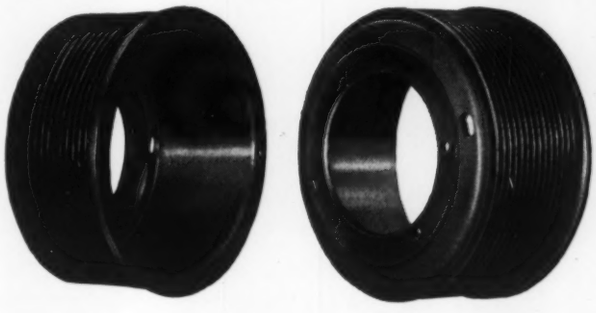
NICKEL CAST IRONS

...Wear and stress and corrosion-resistant cast irons prove their worth in diverse applications

PUMP CASING RESISTS HARSH ABRASIVES

This pump casing on a dredge in San Diego harbor has handled 3,200,000 cubic yards of material averaging 5% rock, 20% gravel, 10% silt. Owners estimate it good for 1,000,000 yards more. Made by Golden State and Miners Iron Works Co., of alloy cast iron containing 1.50 to 2.00% Nickel and about 0.50% chromium.





TAKES THE BRUNT OF 16,000 STOPS AT 50 M. P. H.

Research by leading bus and truck manufacturers proves 2% to 2½% Nickel-chromium cast iron the ideal brake drum material for high-speed, heavy-duty vehicles. In severe tests simulating road braking conditions, with 200 stops at 80 m.p.h. and 16,000 stops at 50 m.p.h., wear on the drum was only 0.002, with no scoring despite temperatures over 800 deg. F.

WITHSTANDS CORROSION FROM CRUDES

For nine months this pump has continuously discharged Gulf Coast crude, with a specific gravity of 76 at 750 deg. F., 1100 p.s.i. Says the manufacturer, Byron Jackson Co., Los Angeles, "The entire output of the plant has been handled by this pump, and undoubtedly a great deal of coke and sediment has passed through this unit, yet the Nickel cast iron inner case shows no noticeable effects of either corrosion or erosion."

Additions of small amounts of Nickel render cast iron uniformly hard, tough and wear resisting, yet capable of being machined and ground to a smooth, glossy finish. Consultation on problems involving the use of Nickel cast irons and other Nickel alloys is invited.

THE INTERNATIONAL NICKEL COMPANY, INC., NEW YORK, N. Y.

ute in an automobile on the Florida beach, is also of Mr. Milbrath's design.

During the past several years, he has developed a line of air-cooled engines, particularly adapted to the industrial field, for various types of machinery. A full line of water-cooled designs is also included.

He was in Washington during the World war, in charge of the engine division, while the U. S. Army standardized trucks were being designed.

♦ ♦ ♦

VICTOR R. WILLOUGHBY, who since 1924 has been general mechanical engineer of the American Car & Foundry Co., New York, has been made vice president in charge of engineering of the company.

♦ ♦ ♦

H. S. HERSEY of C. O. Bartlett & Snow Co., Cleveland, was recently elected president of the Foundry Equipment Manufacturers association. P. J. POTTER of Pangborn Corp., was elected vice president.

♦ ♦ ♦

DR. CHAUNCEY GUY SUITS has been selected as America's outstanding young electrical engineer for 1937, according to an announcement by Eta Kappa Nu, honorary electrical engineering fraternity. Presentation of the award to Dr. Suits, who is research physicist of the General Electric Research laboratory, was made at the AIEE convention in New York.

♦ ♦ ♦

W. NEAL GALLAGHER, president of Automatic Washer Co., has been elected president of the American Washing Machine Manufacturers association.

♦ ♦ ♦

HUGH E. WEIGHTMAN, well-known engineer and designer of process equipment, has been named technical director of the Chemical Equipment Corp., Montpelier, Ind.

♦ ♦ ♦

HAROLD E. CHURCHILL, who has been engaged in research activities at Studebaker Corp., South Bend., Ind., for the past 12 years, has been made assistant research engineer.

♦ ♦ ♦

F. H. MCCORMICK, chief engineer of the electric range engineering department of Frigidaire, has been made manager of the appliance engineering department to succeed Edgar A. Fisher. Before joining Frigidaire several years ago he was assistant chief engineer of Edison General Electric Appliance Co.

♦ ♦ ♦

CHARLES S. PEARCE, who has had considerable experience in the manufacture of porcelain enamel, having been head of the porcelain enameling department of Frigidaire Corp., Dayton, O., and in charge of enameling operations at Davidson Enamel Co., Clyde, O., has been appointed secretary of the Porcelain Enamel Institute Inc., Chicago, to fill the position vacated by George P. MacKnight.

♦ ♦ ♦

ELLERY R. FITCH has been appointed chief engineer of Bendix Westinghouse Automotive Air Brake Co., Pittsburgh. Mr. Fitch, former research engineer of Westinghouse Air Brake Co., Wilmerding, Pa., replaces S. Johnson Jr. who will assume the duties of general engineer with the Bendix Westinghouse company.

♦ ♦ ♦

GEORGE D. SHAEFFER has been named chief engineer of the road machinery division of Gar Wood Industries Inc. For the past 11 years, he has been chief engineer in a similar capacity of the W. A. Riddel Corp., Bucyrus, O.

♦ ♦ ♦

S. ROBERT HIRSCH has been appointed chief engineer of Brunner Mfg. Co., and will have charge of the engineering department. He was formerly assistant chief engineer of the Carbondale division of Worthington Pump & Machinery Corp.

♦ ♦ ♦

H. A. WOOFTER, formerly chief engineer, Federal Machine & Welder Co., Warren, O., recently has been named sales manager of the Progressive Welder Co., Detroit. Prior to his association with Federal, he was vice president and chief engineer of Swift Electric Welder Co., Detroit, for 11 years.

♦ ♦ ♦

HOWARD J. TYZZER, who has been connected with Crosley Radio Corp. since 1933, has been made chief engineer of the household radio division. CLARENCE G. FELIX, formerly in charge of automobile radio development, has been appointed chief engineer of the automotive radio division.

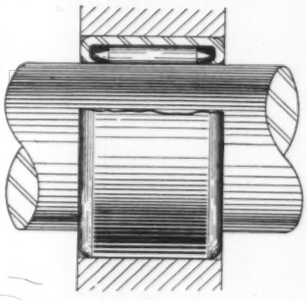
♦ ♦ ♦

DOUGLAS F. MINER has been appointed George Westinghouse Professor of Engineering at the Carnegie Institute of Technology, and will assume his new duties Sept. 1, as coordinator for the Westinghouse cooperative engineering plan under which engineering students will take the usual technical college course and during the same period receive shop and engineering experience at the Westinghouse company. Mr. Miner is manager of the central engineering laboratories and standards of the Westinghouse Electric & Mfg. Co.

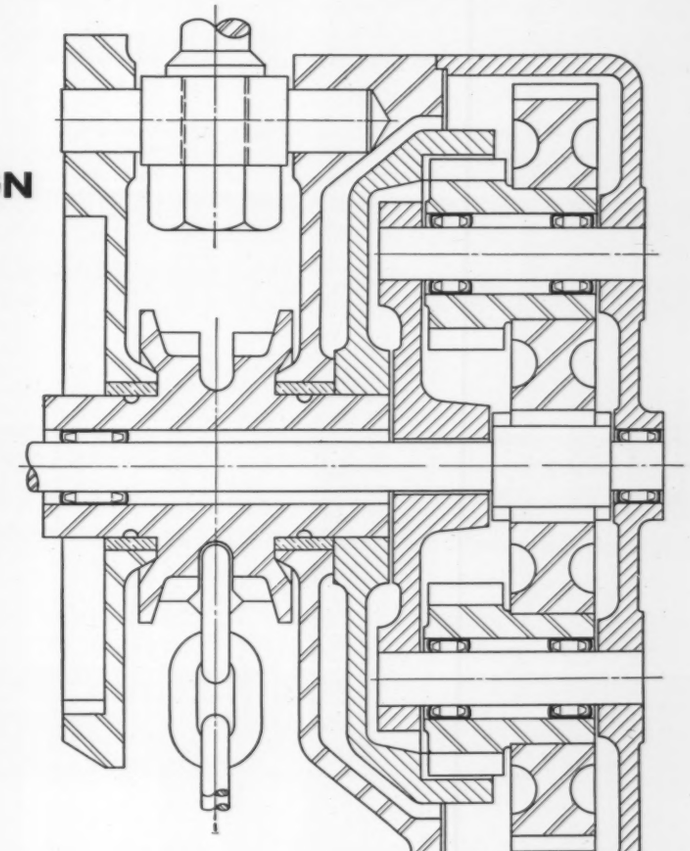
TORRINGTON NEEDLE BEARING

DESIGN AND SERVICE FEATURES

HIGH UNIT CAPACITY SIMPLIFIES PRODUCT DESIGN



Small Sizes Take Heavy Loads



High unit capacity of the new Torrington Needle Bearing, permitting small-size bearings to take severe loads, is a marked aid in simplifying product design. Typical of this advantage is the chain hoist illustrated.

Because of the Needle Bearing's full complement of small-diameter rollers, it is ideally suited to applications involving very heavy intermittent loading, such as is encountered in hoist service. The construction of the bearing—its long axis and small diameter—permits a simple, space-saving design—especially important where several bearings must be mounted in a mechanism of limited size.

Ease of Lubrication

The turned-in lips of the bearing's retaining shell hold ample quantities of lubricant for long periods of service-free operation. This factor is an important aid to satisfactory operation of overhead devices and other products where maintenance and service attention are infrequent.

The low unit cost of the bearing itself and the economies which its use permits in housing design contribute to reduction in product cost, while retaining the advantages of complete anti-friction construction.

These advantages can readily be obtained in your own product. The Torrington Engineering Department cooperates in the laying out of new bearing applications and will be glad to work with you in adapting the Needle Bearing to your products. Further information is given in the Torrington Needle Bearing Catalog, available on request. Write for Catalog No. 9.

The Torrington Company
ESTABLISHED 1866
Torrington, Conn., U.S.A.
Makers of Ball and Needle Bearings
Branch Offices in all Principal Cities

TORRINGTON
NEEDLE BEARING

ASSETS *to a* BOOKCASE

Procedure Handbook of Arc Welding Design and Practice

Published by The Lincoln Electric Co., Cleveland; available through MACHINE DESIGN *for* $1.50 *postpaid.*

This revision, which is the fifth edition of this extremely useful textbook, is a volume of 1012 pages and takes into account recent developments in arc welding. It includes new or revised information on the following subjects: Characteristics of the welding generator; AWS weld symbols; welding costs; high speed automatic welding; high tensile steels; cold rolled steel; medium high carbon steel; chrome steel; SAE steel numbering system; AWS filler metal specifications; machine design; structural design; and new welding applications throughout many other industrial fields. Welding in machinery building is thoroughly covered with the help of numerous practical examples.

As the foregoing paragraph will indicate, and as MACHINE DESIGN has brought out in reviews of prior editions, this book is just as useful to engineers and designers as it is to practical welders and others concerned primarily with the "shop problems" of welding.

□ □ □

Mechanics

By William F. Osgood; published by The MacMillan Co., New York; available through MACHINE DESIGN *for* $5.00 *postpaid.*

Designed primarily for college use as a careful and thorough introduction to the science of mechanics, this book likewise is of very considerable value as a work of reference on this broad subject. It certainly is not a volume to be taken lightly, knowledge of the calculus being essential to its understanding study and reference use.

The author, who is one of America's leading mathematicians, points out that mechanics is not an empirical subject. Its laws—laws that explain the motions of the golf ball, the gyroscope and the skidding automobile, and which make possible prediction of eclipses—are known. Like the laws of geometry they will still be new and important two thousands years from now and will be basic to enginering then, as now.

To assure comprehension of these laws, Professor Osgood—on the basis of his more than 40 years of teaching experience, mainly at Harvard—sees no other way than through systematic inculcation of mathematical theory from the very beginning. This he does in complete coordination with physical principles and with a high degree of clarity and completeness.

□ □ □

A Manual of Porcelain Enameling

Edited by J. E. Hansen; published by The Enamelist Publishing Co., Cleveland; available through MACHINE DESIGN *for* $5.00 *postpaid.*

The art of porcelain enameling is one which lately has come to be closely associated with machinery in many cases — food, beverage and pharmaceutical equipment being examples of the growing trend toward this durable, sanitary and good-looking finish. That there is such a trend which does effect the field of machine design, is attested to by the article, "Age-Old Porcelain Enamel Finds New Machine Uses", in the October, 1937 issue of MACHINE DESIGN.

This book, which is built upon a foundation of two previous and less complete treatises on the subject published in 1927 and in 1932, is made up of twenty-three chapters and a glossary of terms—each by a recognized authority in the branches covered. The 513 pages carry numerous photographs, line drawings, diagrams and charts. Bibliographies following each chapter make it readily possible to delve even further into the subjects should that be necessary.

□ □ □

Segmental Functions

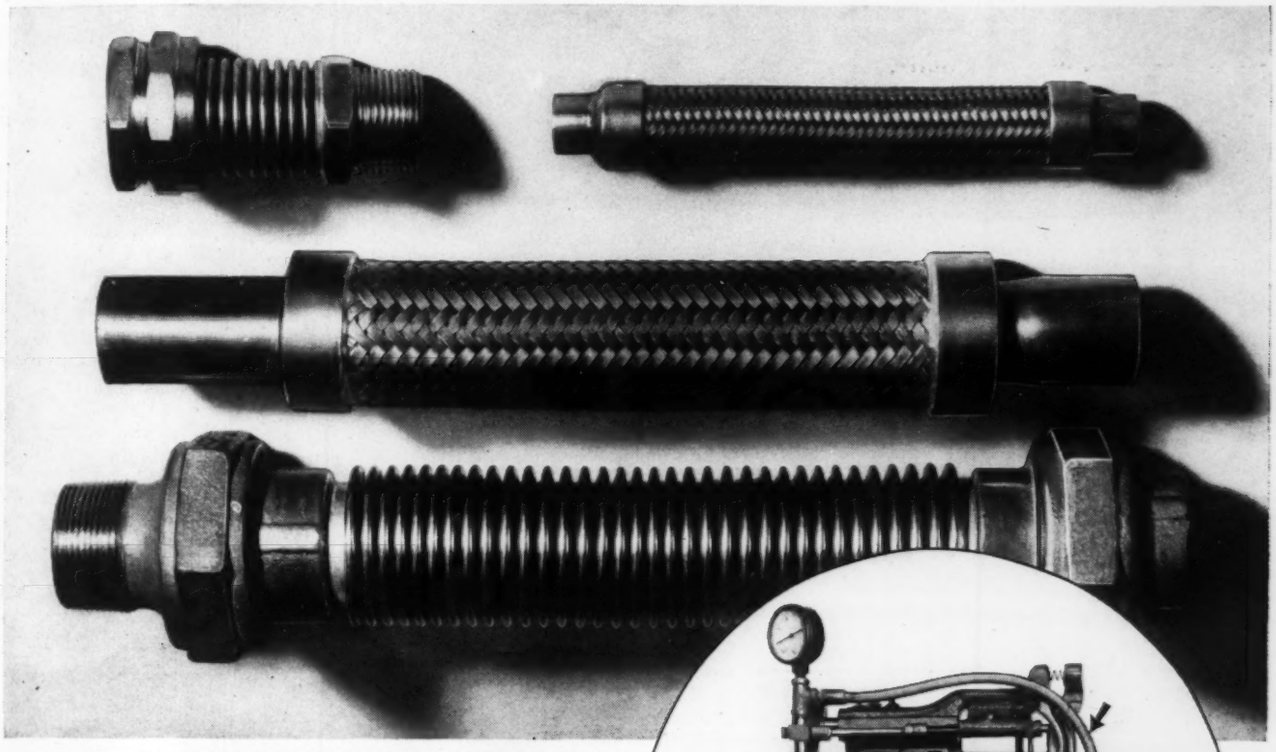
By C. K. Smoley; published by C. K. Smoley & Sons, Scranton Pa.; available through MACHINE DESIGN *for* $5.00, *postpaid.*

Bound in flexible covers in the familiar engineering handbook style, this 185-page volume is given over to text and tables concerned with the solving of circular segments and computation of their areas, when any two of the following five parts are given; the arc, the chord, the radius, the central angle and the height. The author claims to have evolved a new mathematical entity in segmental functions, which accomplishes in the solution of circular segments what trigonometric functions do for the solution of triangles.

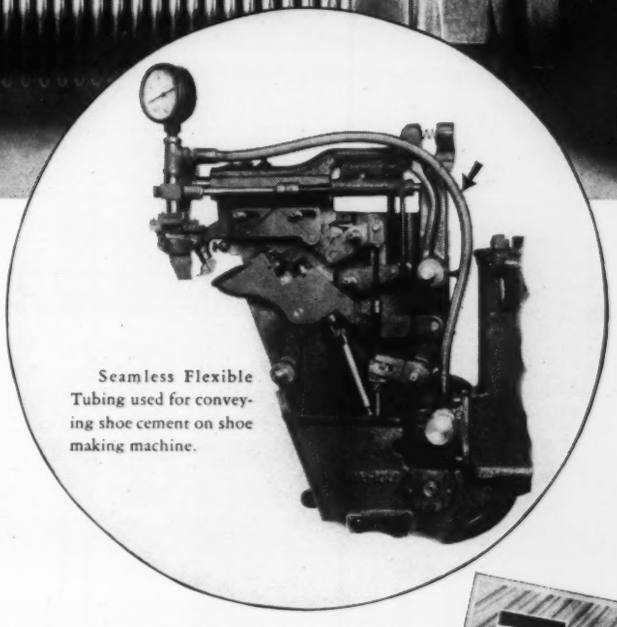
In addition to the foregoing, the book also contains logarithms of numbers from 0 to 10,000; logarithms of feet, inches and fractions thereof from 0 to 200 feet; circumferences, areas, squares, cubes, square roots, etc.; areas and circumferences of circles for diameters in units and fractions; decimal equivalents; and constants frequently used in computations.

Seamless *Flexible* Connectors

...THE SAFETY LINK BETWEEN TWO MOVING PARTS



Assemblies of American Seamless Flexible Bronze Tubing with various types of end fittings used as leak-proof flexible connectors for taking up vibration, misalignment, etc.



Seamless Flexible Tubing used for conveying shoe cement on shoe making machine.

INSTALL American Seamless Flexible Bronze Tubing as original parts on your product. It's cheap insurance against the need for future servicing. Wherever you need a flexible connector or conductor... for misaligned or moving parts, for complete elimination of vibration...the only 100% safe answer is American Seamless Flexible Bronze Tubing.

For the conveyance of air, water, oil, steam or fuel, "American" has no superior. No joints, welds, laps, seams or packing are used in its manufacture. *It's seamless.* That's why it's leak-proof, and that's why more and more designers of machinery of all types are putting "American Seamless" into their specifications.

Write us about your connector problems. Our engineering department has a wealth of information on the use of "American Seamless" on all types of machinery. Consultation of this department entails no obligation. 38322

ANACONDA

FREE REFERENCE HANDBOOK ON SEAMLESS FLEXIBLE METAL TUBING

The most dependable *flexible* connector for conveying liquids or gases under high pressures . . . made from special high tensile strength *seamless* Bronze Tubing. Handbook contains descriptions, illustrations and valuable engineering data. Write for Bulletin SS-3.

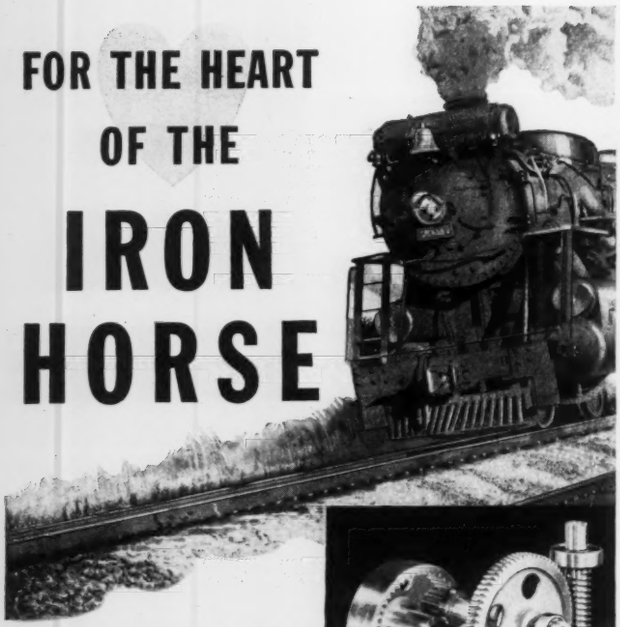
THE AMERICAN BRASS COMPANY

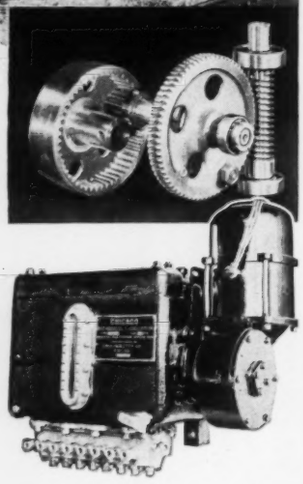
American Metal Hose Branch

General Offices: WATERBURY, CONNECTICUT

FOR THE HEART OF THE

IRON HORSE





● When Ohio Injector Co. developed the Chicago electric motor driven locomotive lubricator, long experience in supplying railway needs taught them the essential requirement—unfailing efficiency under terrific shock and vibration. They knew the high cost of locomotive breakdowns.

They took no chances. Unit after unit failed to meet the rigid requirements. On recommendation, Ohio Gear engineers were called in, traced the fault, suggested a change, redesigned the drive and supplied gears and housing for the new design.

Today, on many railroads, Chicago lubricators are serving with never a failure.

Check Ohio Gears, Ohio Gear engineering for your own gear needs. You'll find the advantages and the savings well worth while. Send for a catalog.

THE OHIO GEAR CO.

1338 E. 179th Street · Cleveland, Ohio

Representatives

*LOS ANGELES, CALIF. J. W. Minder Chain & Gear Co., 927 Santa Fe Avenue.
*SAN FRANCISCO, CALIF. Adam-Hill Co., 244-246 Ninth Street.
INDIANAPOLIS, IND. A. R. Young, 518 North Delaware Street.
LOUISVILLE, KY. Alfred Halliday, 330 Starks Building.
DETROIT, MICH. George P. Coulter, 322 Curtiss Building.
MINNEAPOLIS, MINN. W. H. Erskine, Box 72, Traffic Station.
BUFFALO, N. Y. F. E. Allen, Inc., 2665 Main Street.
NEW YORK CITY, N. Y. Patron Millwright & Transmission Co., 154-156 Grand Street.
NEW YORK CITY, N. Y. E. G. Long Co., 50 Church Street.
GRAND RAPIDS, MICH. W. H. Slaughter, 419 Oakdale St., S. E.
NEW ENGLAND. George G. Pragst, 260 Esten Ave., Pawtucket, R. I.
PITTSBURGH, PA. Industrial Sales & Engineering Co., Box 8606, Wilkinsburg, Pa.
SALT LAKE CITY, UTAH. A. O. Gates, 619-629 South Fifth West Street.
*Stocks carried.

OHIO GEARS

Noteworthy Patents

TO eliminate constant engagement and disengagement when operating speed coincides with its adjusted speed, Gustaf Jonsson of Huddinge, Sweden, has invented the automatic centrifugal clutch unit, *Fig.* 1, below. Patent No. 2,100,946 covers this. While engagement occurs at predetermined speed, disengagement always is at lower speed.

The unit is shown with an automotive gear box, engine shaft being at left in side elevation. Flywheel is coupled through a common disk clutch (right) to a sleeve driving "second gear". Driving member of the centrifugal clutch is rigidly connected with a disk shaped clutch member having at its outer edge a ring supported by and rotatably mounted in relation to clutch disk.

Within the ring the clutch disk also supports the

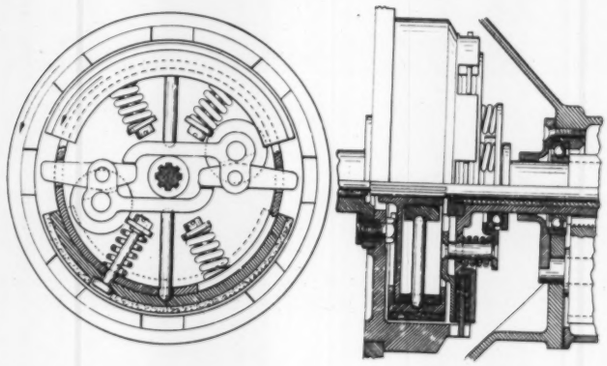


Fig. 1—Centrifugal clutch automatically engages at predetermined speed but disengages at lower speed

U-shaped centrifugal clutch segments. These segments are held by bolts which allow centrifugal radial displacement against resistance of compression springs. When engaged, these segments cause direct drive, second gear then being unclutched by other means. Each clutch segment has a weighted, pivoted bell crank levered to the clutch ring in such a way that centrifugal pressure is augmented by that due to frictional turning of the ring.

Pistons Drive Each Other

DESIGNED for supplying fluid under pressure for various purposes, including the actuation of vehicle brakes of hydraulic type, the pump shown in

Jesse Owens, world's record breaker, winning a 220 yard low hurdle event in an N. C. A. A. Meet.

SPECIFICATIONS
TYPE KD MOTOR

Series (Universal) 0-60 cycles; HP range, 1/25—1/75; full-load speeds 70-7 RPM; amperes, 1.39; watts input, 148; duty, continuous; temperature rise, 40° C; method of cooling, internal fan; bearings, composition bronze; housing cast iron; finish, black crinkle enamel; weight, 11 lbs.

Like the Winner of a Track Event

A DUMORE HAS THAT EXTRA "SOMETHING"

What's your power problem? Is it different . . . does it have hurdles "any old motor" can't handle? Does it call for a unit that's got the guts to keep going when others "let go" . . . that delivers smooth dependable power in a quiet, steady way . . . the kind of power that's been selected for delicate astronomical-telescope controls, life-saving surgical devices, cost-cutting modern business machines, precision grinding tools, and the like? If that's your power problem, Dumore power is your answer.

In Dumore motors you'll find extra endurance and precision . . . built in by 25 years of exacting manufacturing methods. (1) Their armatures are dynamically balanced; (2) the commutators are ground concentric with the bearings for longer brush life; (3) windings are expanded at high speed then sealed to eliminate centrifugal "breathing"; (4) armature leads are swaged by special Dumore process to commutators for 100% electrical contact; (5) every motor is run-in to seat its brushes properly and (6) is inspected five times in the process of manufacture.

Before you buy, let Dumore engineers study your problem and suggest the best motor suited to your needs. Write for latest Dumore catalog and engineering service blank . . . without obligation.

THE DUMORE COMPANY - DEPT. 128-E - RACINE, WIS.

DUMORE MOTORS

FOR Extra Power Hours

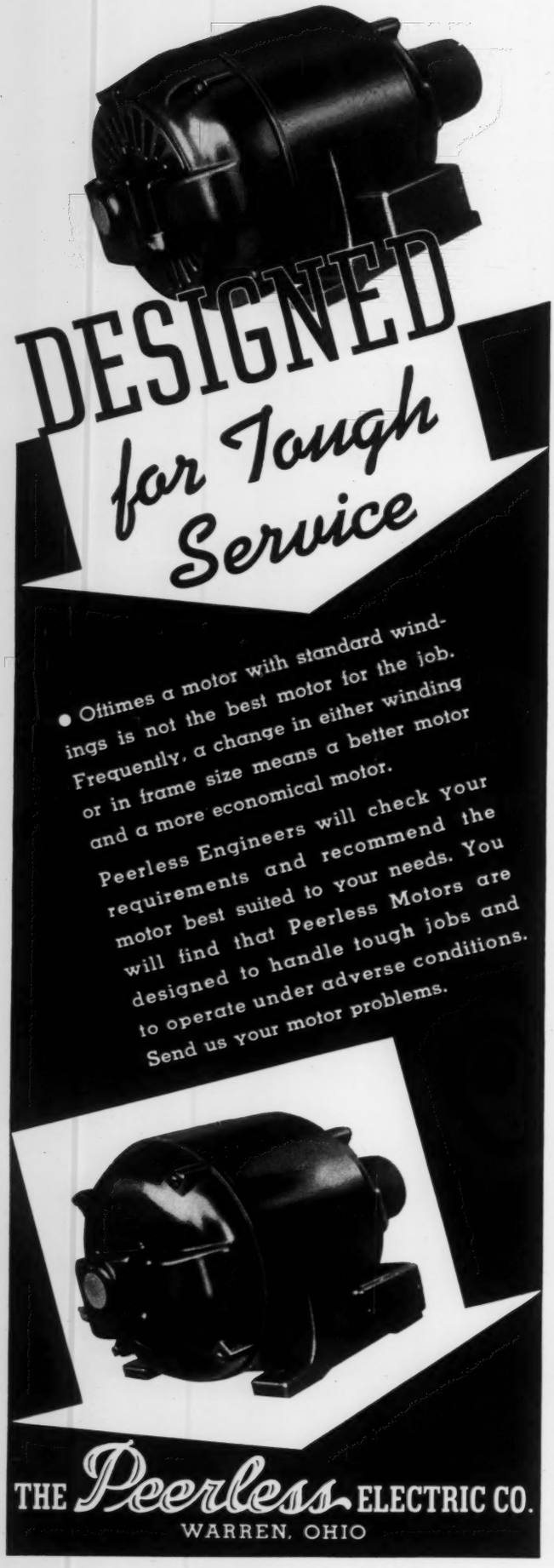

DESIGNED
for Tough
Service
• Oftimes a motor with standard windings is not the best motor for the job. Frequently, a change in either winding or in frame size means a better motor and a more economical motor.
Peerless Engineers will check your requirements and recommend the motor best suited to your needs. You will find that Peerless Motors are designed to handle tough jobs and to operate under adverse conditions. Send us your motor problems.
THE Peerless ELECTRIC CO.
WARREN, OHIO

Fig. 2 has recently been patented by Bert A. Linderman of Homestead, Fla. The number of this patent is 2,096,907.

This pump has two cylindrical rotors, each having an axial cylindrical aperture the wall of which engages with a close sliding fit with the outer wall of a valve member. The rotors are on inclined axes which brings both their rims—which are worm wheels—into mesh with a single driving worm at the top of the pump casing. Thus they are driven simultaneously and in the same direction.

Each rotor, with its cylinders, cylinder ports and pistons in combination with the associated valve members and fluid conduits, comprises a complete pumping unit save in one respect. That exception is that neither element by itself has the means for driving its pistons on their fluid ejection strokes. When acting in unison however, as they do in the assembled mechanism, the pistons in one rotor serve to actuate those in the other. This action is shown clearly in the lllustration, which also shows the system of piston return springs.

Liquid is drawn from the base of the pump through the integral channels which appear in section in the cut. These lead to the cylinders by way of chambers in the bearings on which the rotors revolve. On the opposite sides of the bearings are larger chambers (covering approximately 90 per cent of the bearing circumference) through which discharge takes place by way of ports in the side of the pump casing.

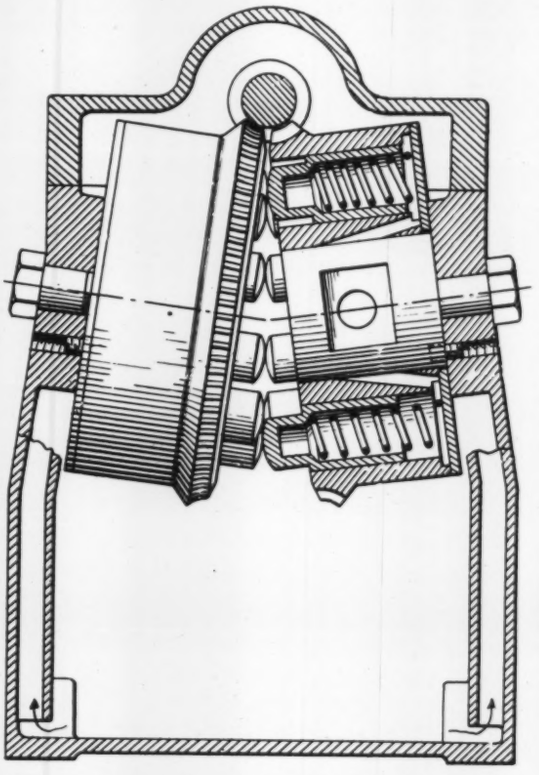


Fig. 2—Pistons in one rotor serve to actuate those in the other rotor in this new type pump

The KEYSTONE *of Modern Machine Accuracy*

SUPER-PRECISION

Leadership
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Strom
SRB
GURNEY
BALL BEARINGS

● In machine design where high speed is a factor and fine surface finish important, engineers depend on M-R-C Super-Precision Ball Bearings. With eccentricities of less than .0001", the M-R-C Super-Precision is probably the finest ball bearing available today.

While comparatively few industries require such extreme accuracy, the methods developed to produce it result in making all M-R-C Ball Bearings more uniform.

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Factories at: JAMESTOWN, N. Y. . . . PLAINVILLE, CONN.

M-R-C *Ball Bearings*

GURNEY ● SRB ● STROM

M-R-C SUPER-PRECISION BALL BEARINGS ESTABLISH NEW STANDARDS OF ACCURACY

Choose

from this complete line of

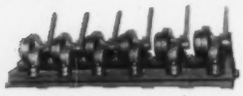
AIR CONTROL VALVES

Hannifin "Pack-less" disc-type air control valves provide positive, accurate control of air operated equipment, and since there is no packing, there is no leakage or packing maintenance trouble.

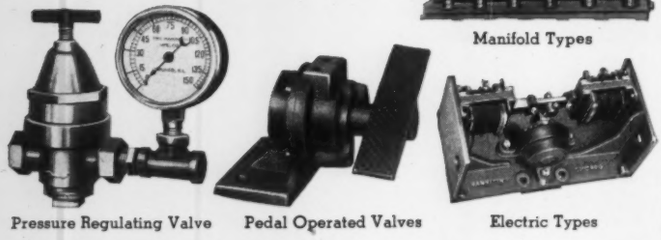
The complete line of standard types includes hand and foot operated models, spring return, heavy duty, manifold, and electric types for all air control requirements. Their performance means economical use of air power and smooth, easy handling. Write for Valve Bulletin 34-MD with complete descriptions.

Simple "Pack-less" design

Rotary Type Valves — Spring Return Valves — Hand Control Valves



Manifold Types



Pressure Regulating Valve — Pedal Operated Valves — Electric Types

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Engineers • Designers • Manufacturers
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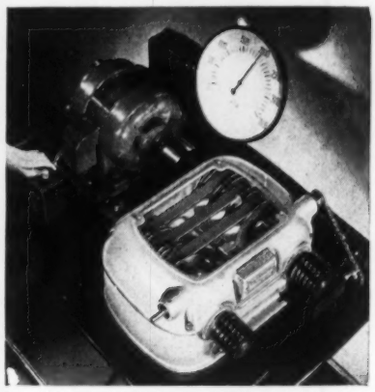
HANNIFIN "Packless" AIR CONTROL VALVES

NEW *Materials and Parts*

Variable Speed Drive Announced

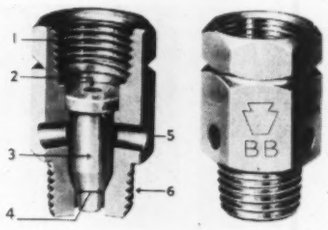
UTILIZING multi-groove, vari-pitch sheaves, The Texrope Division, Allis-Chalmers Manufacturing Co., Milwaukee, has placed on the market an improved variable speed unit. The speed changer consists of a ruggedly constructed, compact unit, applicable to all manner of machines. It is designed with double shaft extension and driven from a standard motor. Where the speed change is to be adjusted manually the unit is provided with a readily accessible handwheel. However, it may easily be equipped with a small electric motor for remote control. Present range of capacities includes ratings up to 33 horsepower with ratios as high as 3¾ to 1.



As optional equipment, variable speed drive may be equipped with small electric motor for remote control

Safety Device Limits Grease Pressure

LUBRICATION safeguard which makes it virtually impossible to overload antifriction bearings through high pressure application has been developed by Keystone Lubricating Co., Philadelphia. Known as the Keystone BB fitting, the device is used in connection with the ordinary grease cup or high pressure fitting, and definitely protects



When lubrication pressure reaches a predetermined point it moves plunger 3 and escapes through holes 5

Lanston Monotype Found Six Reasons for Using

TEXTOLITE

EACH ONE MEANT PRODUCT IMPROVEMENT OR ECONOMY

The Barrett Figuring-Listing Machine is a rapid, efficient adding and listing machine, weighing only ten pounds and occupying a space of only one half the size of a business letterhead. The housing is molded of G-E Textolite

WHEN the Lanston Monotype Machine Company designed the new Barrett Figuring-Listing Machine, its engineers remembered General Electric's success in molding housings for other progressive manufacturers. Consequently, they called in a G-E Textolite specialist to help them apply Textolite to their machine with "protection to the precise mechanism" a prime factor.

But like many others who have investigated, carefully, the possibilities of Textolite, they found that in addition to complete protection it provided other advantages which helped make their product better. For instance, the lightness of Textolite reduced the weight of the machine, and its resilence deadened the sound of the mechanism. Then, too, no machining of the Textolite housings was necessary, as they were shipped from one of G.E.'s three modern molding plants to the Barrett factory, ready for assembly. And the black luster of the Textolite housing assured beauty and lasting finish.

In addition to the finest types of molding materials available, you can rely on General Electric's fifty years of molding experience and its complete engineering, designing and manufacturing services to solve your molding problems and to show you ways of cutting production costs or improving the salability of your product — no matter how small, large, intricate or simple the part may be.

Write Section M-5, Plastics Department, General Electric Co., One Plastics Avenue, Pittsfield, Mass., for a copy of our new bulletin "One Plastics Avenue."

MOLDING PLANTS IN PITTSFIELD, MERIDEN, FORT WAYNE

GENERAL ELECTRIC

PD-45

ONLY Ampco Metal, Inc. understands the method of combining copper, aluminum and iron to produce the "Ampco Phase" . . . the particular structural formation which provides Ampco Metal with those unmatched qualities which have led to its adoption by hundreds of nationally prominent manufacturers.

If you require a non-ferrous alloy that provides the utmost in wear resistance—tensile strength—corrosion resistance then insist on genuine Ampco Metal, distinguished by the diamond trade mark reproduced here. It is available only from this Company and its four licensee foundries . . . in six grades of varying hardness and physical properties. The book "Ampco Metal—Its Uses in Modern Industry" will interest you.

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"The Metal without an Equal"
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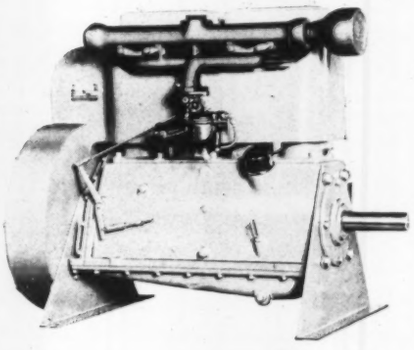
against the hazards of uncontrolled lubrication. The maximum pressure under the control is 2½ ounces per square inch on the bearing proper, making it impossible to overload and force grease from the bearing housing into motor windings or other adjacent parts. The BB fitting operates on the principle of molecular friction and introduces the lubricant to the bearing through a central duct. When the pressure at the bearing reaches 2½ ounces, back pressure forces the lubricant past a calibrated orifice in the base of the fitting and out through relief ports at the side.

Four Cylinder, Air-cooled Engine

OF twenty-five horsepower, a four-cylinder, heavy duty engine has been added to the air-cooled line of Wisconsin Motor Corp., Milwaukee, making a range of engine sizes from 1 to 28 horsepower in single and four-cylinder models. The new model



Valves and engine accessories are all lubricated from main engine oiling system

AM4 has a 3¼-inch bore by 4-inch stroke and a displacement of 132 cubic inches. It develops 16 horsepower at 1200 RPM, 22 at 1600 RPM, 25 at 1800 RPM and a peak of 28 horsepower at 2400 RPM. Outstanding feature of the engine is its light weight — 340 pounds. All parts are automatically lubricated from the engine oiling system. It is recommended for all types of equipment in the industrial and agricultural fields.

Larger Magnetic Chuck Offered

LARGER than the two previous models, a new magnetic chuck (No. 824) of the permanent magnet type has been announced by Brown & Sharpe Mfg. Co., Providence, R. I. It does not require electric current and all electrical connections, wires, switches and auxiliary generators are eliminated. The magnets, of a special alloy, are exceptionally strong and last indefinitely. The chuck does not heat under any conditions and the work can be held as long as desired without damage to the work or chuck. Like

Experience Specifies

LINK-BELT
POWER TRANSMISSION
EQUIPMENT

● Link-Belt anti-friction and babbitted bearing transmission units and the complete line of Link-Belt positive drives—silent and roller chain drives, speed reducers, and variable speed transmissions—afford better ways of solving transmission problems. Among the results you get are lower power consumption—less lubrication needs—the elimination of much of that day-in-and-day-out maintenance—and greater dependability . . . . Send for general catalog No. 700.

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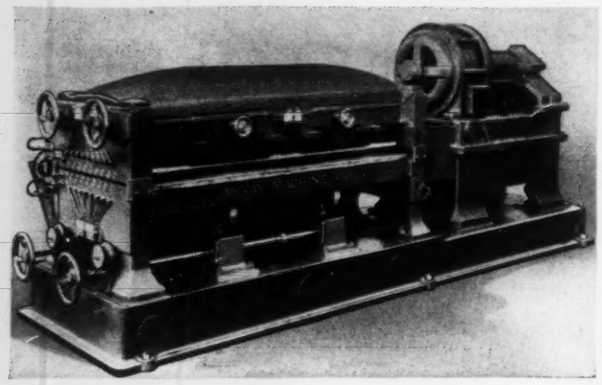
Farval Systems WILL HELP KEEP YOUR CUSTOMERS' COSTS *in the Black*



AVOID SHUTDOWNS • SAVE LUBRICANT • ELIMINATE LABOR OF OILING
INCREASE PRODUCTION • REDUCE POWER CONSUMPTION • CUT REPAIR BILLS
PROLONG MACHINE LIFE

To Design Engineers:

Have you considered *all* of the economies of a Farval Centralized System of Lubrication?

"It eliminates bearing troubles." Yes—but that's only the *beginning.* Check the list below the picture and note the *other* net savings that your customers can always realize when all bearings are properly lubricated at all times!

Even on curtailed operations, the net savings that Farval effects will write off its cost within a few months. *And*—Farval continues to save, long after the investment has been retired.

Farval will deliver oil or grease to a group of bearings, in exact, measured quantities from one central station, at regular intervals. It can be readily installed on existing equipment and we will be glad to have our Representative call at your convenience, with complete Engineering Data. The Farval Corporation, 3265 East 80th St., Cleveland, Ohio.

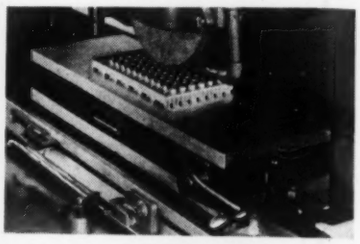
Affiliate of The Cleveland Worm & Gear Company, Manufacturers of Automotive and Industrial Worm Gearing.

FARVAL

CENTRALIZED SYSTEM OF LUBRICATION

Special Delivery to Every Bearing

other Brown & Sharpe magnetic chucks of the permanent magnet type, it holds work firmly when the crank is in the "on" position and releases work by a simple 180-degree movement of the crank. An

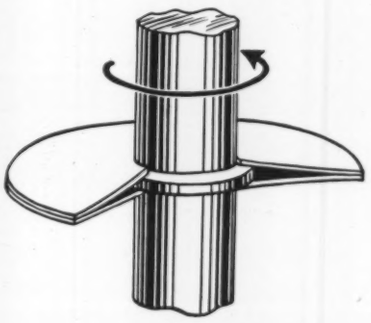


An adapter plate for small pieces of work is shown on new magnetic chuck

adapter plate (No. 824A) for use with the new chuck holds pieces too small to be held readily on the regular surface by use of narrow steel strips or bars with nonmagnetic brass spacing strips.

Packless Seal for Revolving Shaft

FOR use with equipment where a shaft or pipe revolves or oscillates through the wall of a tank, pressure vessel or vat, and a seal must be maintained around the shaft or pipe, a packless unit has been developed by Jas. P. Marsh Corp., 2073 Southport avenue, Chicago. Basic principle of unit is shown in illustration. It consists of shaft or tube on which a collar is machined. Pressing against the upper and lower faces of this collar are stainless spring steel

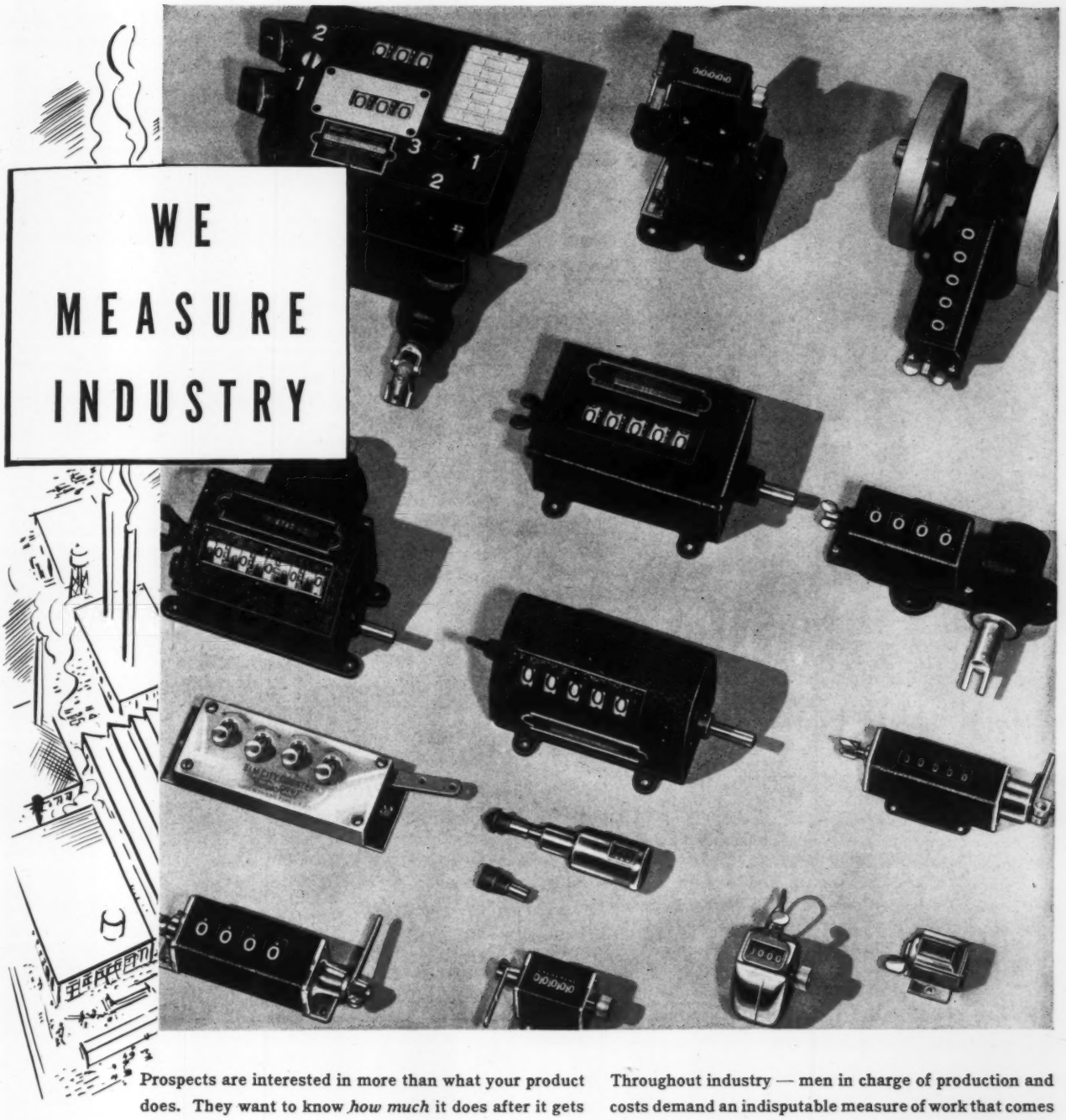


Stainless spring steel wafers pressing against shaft collar form an effective pressure seal

wafers. They form a close, uniform contact around the faces of the shoulder when compressed together around their outer edges, forming a pressure seal that is particularly effective. The unit is available as a self-contained flanged assembly and in a number of other standard and special forms in a large range of sizes.

Adjustable Pulley for Speed Unit

AN addition to the line of variable speed equipment made by Lewellen Manufacturing Co., Columbus, Ind., is a variable speed motor pulley. This pulley fits the shaft of a standard motor and



WE MEASURE INDUSTRY

Prospects are interested in more than what your product does. They want to know *how much* it does after it gets on the job.

For instance: — Manufacturers want to know how many parts each punch press stamps each day. Printers carefully watch the count of sheets coming off the press. Truck owners must have a tamper-proof record of miles covered per dollar spent. Yes, even the office manager is eager to know the number of strokes — or how much work — each typist does a day. For these are facts that measure performance — facts that speak for themselves.

Throughout industry — men in charge of production and costs demand an indisputable measure of work that comes under their charge. And they *get* this measure from the Veeder-Root counting devices that are built into the thousands of products serving industry.

Can you make your product more helpful — and therefore more saleable — to men in industry by building in a counting device? Write for the booklet that answers this question for you — the Veeder-Root booklet "Counting Devices" — an interesting illuminating booklet on *Counters for Every Purpose.*

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GRIT

is okay in a

bulldog

not in a pencil...

When you see a draftsman jump into the air and tear his hair, most likely it's because a piece of grit in his pencil has just ruined his drawing. A. W. Faber's "Castell" Drawing Pencil is made by the microlette process with a soft, natural graphite between 99.8% and 99.5% pure. That's why "Castell" never scratches, never smudges, is never brittle in even the hardest degree. Yes, it costs a few pennies more, but craftsmen are happy to pay the difference. Next time order "Castell".

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DRAWING PENCIL 15c
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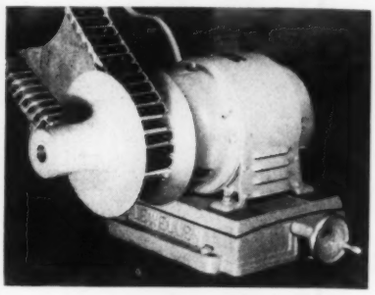
drives directly to a pulley or sheave on the driven shaft. The motor and pulley are mounted on an adjustable base, permitting infinite variation of speed of the driven shaft. Features of this newly designed pulley are: Positive equalized disk travel

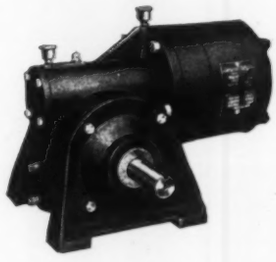


Pulley has positive equalized disk travel in both directions and low spring pressure in all positions

in both directions, uniform low spring pressure at all pulley diameters to prevent belt buckling, pressure lubrication to all bearing surfaces, all working parts completely enclosed to exclude dirt, and use of high tensile strength castings with surfaces machined.

Motorized Speed Reducers

IMPROVED line of motorized, worm gear speed reducers has been placed on the market by Janette Manufacturing Co., 557 West Monroe street, Chicago. Six styles are available, ranging from ⅛



Worm gear is supported on ball bearings; roller bearings are used in gear box

to 7½ horsepower. Single or double row grease-lubricated ball bearings are used in motors; tapered roller bearings are used to mount the gears. Reducers may be supplied with a wide variety of motor types in either direct or alternating current.

Timer Available in Several Types

FOUR types of a new timer made by the Zenith Electrical Co., 607 S. Dearborn street, Chicago cover a variety of time control applications. In type P-24 the time periods are set at factory and signal operates every 5 seconds or as predetermined. Type P-524 is similar except time periods can be set at any time. Type P-24A and P-524A are like other two models except operating period is adjustable from 1 to 15

LARGE FLANGES

make production costs higher

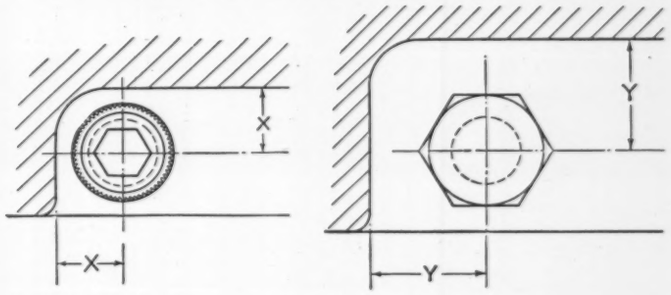
Keep them narrow and lighter by planning for and specifying

KNURLED

UNBRAKO

SOCKET HEAD CAP SCREWS

Compare these plan views



See how the Knurled "Unbrako" snuggles right into the corner.

Notice the great open spaces necessary for the hex-head and wrench.

The amount of space and materials that can be saved by using Knurled "Unbrakos" is really considerable. They fit way into the corner, so that you can provide smaller and lighter flanges. This brings the screw head closer to the joint and increases their holding power. And, in those spots you so often encounter, where there is just not enough room to tighten up a hex head nut —try an "Unbrako"—it will answer your problem, nine times out of ten.

Another advantage of these nuts most designers speak about is the attractive finish the knurled head gives. Quite an improvement over the old style, plain head.

You ought to have the "Unbrako" Catalog. You'll find it handy for reference.

Fig. 1434 U. S. and Foreign Pats. Pending

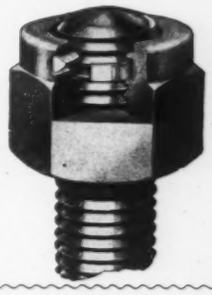
The two easy and ingenious ways Knurled "Unbrakos" can be locked after countersinking is shown in our catalog. You'll want to see how it's done.

DESIGNERS APPROVE

UNSHAKO

The Nut that can't shake loose

—the neat design of this self locking nut. It's a little different from an ordinary hex head nut because the locking device, a ring that works like a brake band, is built right on the inside. It's reliable, too. Tests in most all lines of industry have proven it to be unfailing. Write for the complete details about it.



Pat'd. and Pat's. Pending Fig. 1510

Cut-out section showing Locking Ring in place.

Ask us about these, also

"UNBRAKO"
Hollow Set Screws

It can take real punishment, finest materials, that's why. In use nearly everywhere.

"UNBRAKO"
Self-Locking Hollow Set Screws

Where a set screw mustn't work loose use this. More than 2,000,000 in use attest its value.

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Stock widths 30″ or 60″...and in rolls of long lengths. Thicknesses—1 ounce per square foot to 5 ounces per square foot (approximately .0015 inches to .007 inches)

NON-POROUS . . . RUST-PROOF

Practical uses for Anaconda "Electro-Sheet" Copper in new fields are innumerable.

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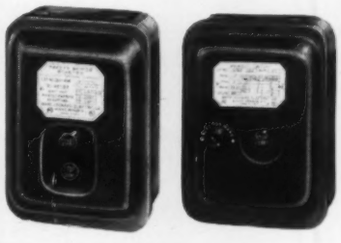
MVB-4

seconds. Timer is driven by a synchronous motor and the standard model has a legible 24-hour dial and 1-hour dial cam. Ninety-six signal periods during each 24 hours are made possible by this time control device.

Synchronous motor-driven timer has maximum of ninety-six signal periods in 24 hours

Two Motor Starting Switches Offered

TWO motor starters have been added to the line of control devices made by Ward Leonard Electric Co., Mount Vernon, N. Y. Bulletin 2851, a new manual, across-the-line type motor starter and protective switch has thermal overload protection with pushbutton operating feature. A depression in cover of the steel enclosure prevents accidental contact.

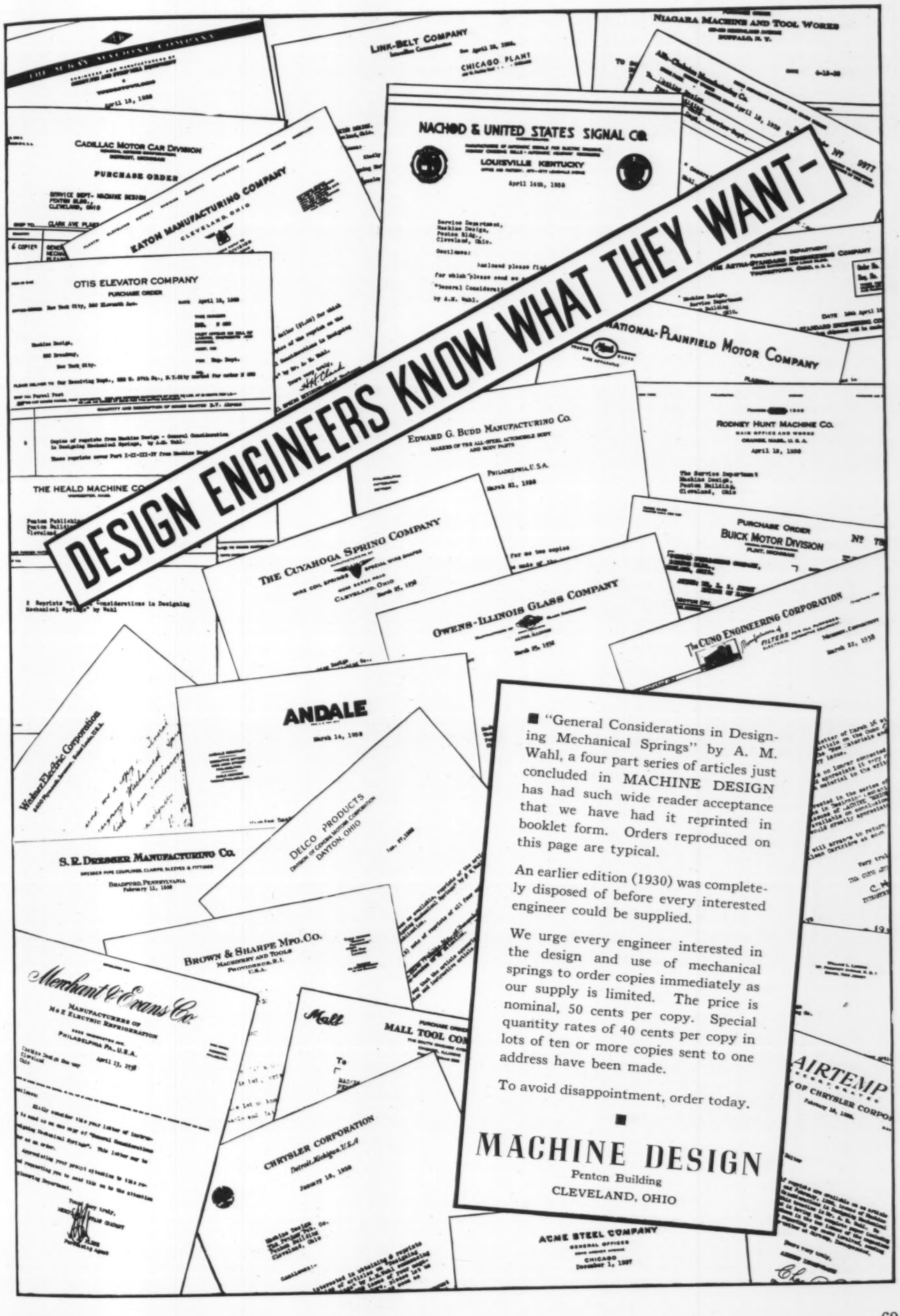


Motor starters have protective thermal device and pushbuttons for easy operation

Bulletin 4002 is an alternating current, across-the-line type motor starter for non-reversing service. Starter provides thermal overload protection, pushbutton operation and a three-position selector switch in the cover. On "automatic" position, starter can be operated only from remote control station or pilot device. In "hand" position, starter operates immediately and stays in running position until switch is turned to "off".

Oilproof Pushbutton Station

LOW-PRICED, compact, standard-duty pushbutton stations specifically designed to resist the de-


DESIGN ENGINEERS KNOW WHAT THEY WANT—
■ "General Considerations in Designing Mechanical Springs" by A. M. Wahl, a four part series of articles just concluded in MACHINE DESIGN has had such wide reader acceptance that we have had it reprinted in booklet form. Orders reproduced on this page are typical.
An earlier edition (1930) was completely disposed of before every interested engineer could be supplied.
We urge every engineer interested in the design and use of mechanical springs to order copies immediately as our supply is limited. The price is nominal, 50 cents per copy. Special quantity rates of 40 cents per copy in lots of ten or more copies sent to one address have been made.
To avoid disappointment, order today.
■
MACHINE DESIGN
Penton Building
CLEVELAND, OHIO

WALDRON *Flexible* COUPLINGS

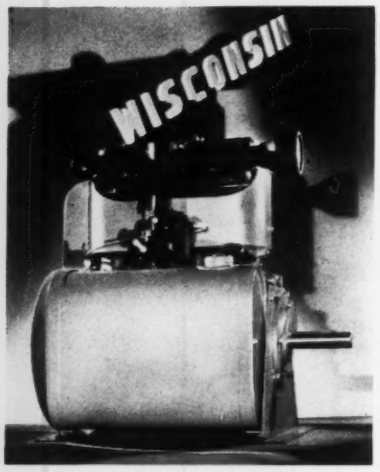
a Type and Size for Every Purpose

GEAR TYPE
Medium Duty
Heavy Duty
FRANCKE
Standard
Marine
SPECIAL
Types

Forged steel; advanced design and construction; for all loads, all drives. Catalogs give sizes, service factors, prices.

WRITE For CATALOG

Manufactured by
JOHN WALDRON CORP.
NEW BRUNSWICK, N. J.



A reproduction of Model AC4 — 8 to 16 H. P. engine with side mounted gas tank.

A complete line 1 to 16 H. P.

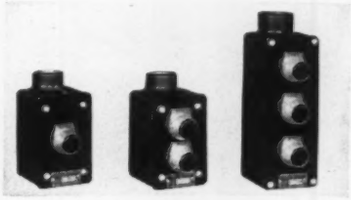
SAFE — DEPENDABLE POWER FOR ANY JOB — ANY CLIMATE

Wisconsin Heavy-Duty Air-cooled Engines require no "Fussing-with" or special attention. They take care of themselves.

HEAVY DUTY AIR COOLED ENGINES by WISCONSIN MOTOR CORPORATION

WISCONSIN
MOTOR CORP., MILWAUKEE, WIS.

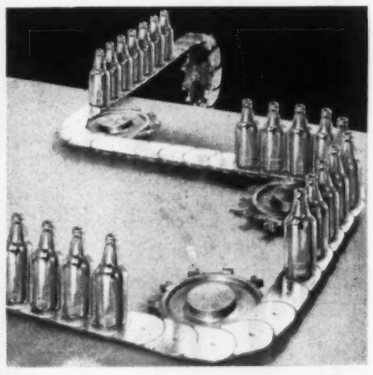
teriorating action of oil and dirt encountered in machine tool applications are announced by General Electric Co., Schenectady, N. Y. These stations are provided with a graphited packing ring between the button proper and the bushing, or oil guard. This packing ring prevents seepage of oil or grease from operator's gloves or hands into the button mechanism. The line includes flush-mounted, surface-mounted, momentary-contact, and selector switch units.



Pushbutton stations are provided with graphited packing ring between button proper and bushing to prevent oil seepage

Carrier Chain Drives in Two Planes

UNIVERSAL carrier chain is the designation of a chain announced by Link-Belt Co., 519 N. Holmes avenue, Indianapolis, which is capable of operating in two planes and particularly well suited for conveying bottles, jars, etc., in process of manufacture. The two-plane travel feature makes it practical to use this chain in rectangular, circular, semicircular or irregular paths, and employ but one conveyor.



Carrier chain is practical for use in irregular paths because of two-plane travel characteristic

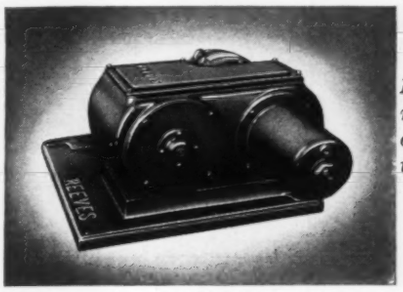
Remote Control for Vari-Speed Drive

NEW type of automatic and remote control for use with the Reeves Vari-Speed Motodrive has been announced by the Reeves Pulley Co., Columbus, Ind. Known as the fluid pressure control, the new device is available for all models of the Motodrive. It can be used to regulate speed automatically from pressure variation as in stoker feed, maintenance of constant fluid pressure in a pipe line, uniform tension between machine sections or between a machine and rewinder, and similar require-

(*Continued on Page* 73)

(*Continued from Page 70*)

ments. The complete control consists of a bellows shifting mechanism mounted on the variable speed drive, an adjustable pressure reducing valve located where desired, and connecting pipes. Fluid pressure is transmitted by oil, water, steam, gas or

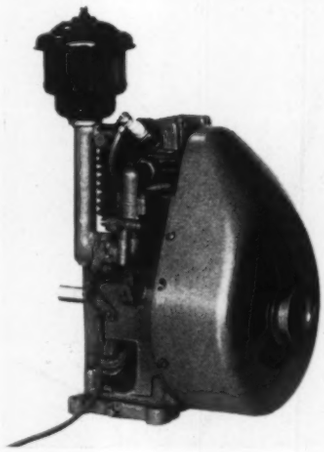


Bellows shifting mechanism may be actuated by oil, water, steam, gas or air

air to the bellows shifting mechanism which operates to increase or decrease speed on the Motodrive. Pressure gages may be used to indicate relative speed of the variable speed unit.

Small Aircooled Engines

THREE new aircooled engines of ½, ¾ and 1 horsepower have been announced by The Lauson Co., New Holstein, Wis. The single horsepower engine has outstanding characteristics of light weight, advanced cooling, and utilizes ball bearings. The ½



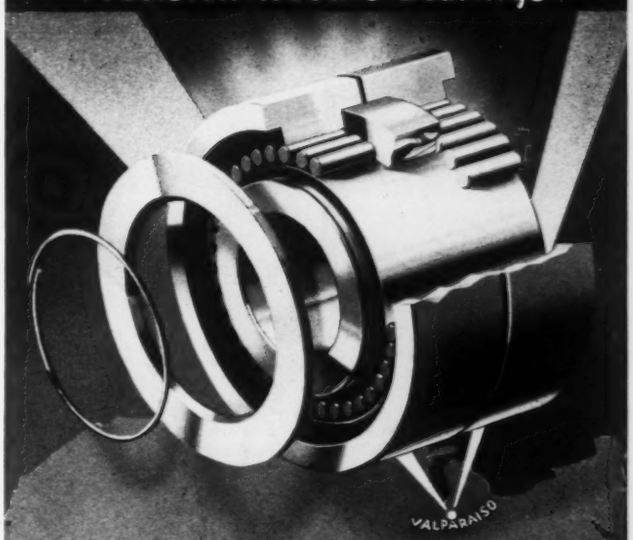
Efficient cooling, light weight, and ball bearing-mounted crankshaft feature new motor line

and ¾ horsepower models are especially adapted for lawn mowers, sprayers, dusters and garden tractor applications. These engines have dust-sealed magnetos, screened-in flywheel housing and oilbath air cleaners.

Coupling for Light Loads

SUITABLE for applications where the load is not in excess of one-quarter horsepower, a flexible,

Industry Runs On
McGILL
MULTIROL
Precision Needle Bearings



The Original Needle Type Bearings

U.S. Pat. No. 1,985,693

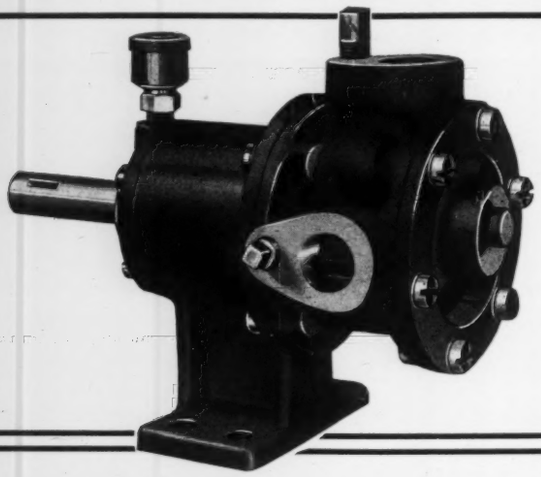
THE great load capacity of McGill *MULTIROL* Precision Bearings in limited space is revolutionizing radial bearing practice in machine design throughout the industry.

Since their introduction by McGill eight years ago, *MULTIROL* bearings have definitely proved their ability to far outrun plain bearings, and frequently other antifriction types, in a wide variety of uses — especially under sustained heavy or intermittent shock loads. Investigate *MULTIROL* adaptability to equipment you design or build. *MULTIROL* bearings are stocked in a wide variety of standard sizes from ⅜ to 6-inch bore, single and double rows of rollers, at low, volume production prices. Corrosion and heat resisting types and special designs engineered to individual needs.

Send for Bulletin No. 37

McGILL MANUFACTURING CO.
Bearing Division, 1450 N. Lafayette St.
VALPARAISO, IND.

WE WOULD LIKE TO SELL YOU A
PUMP *that you can* **FORGET ABOUT!**

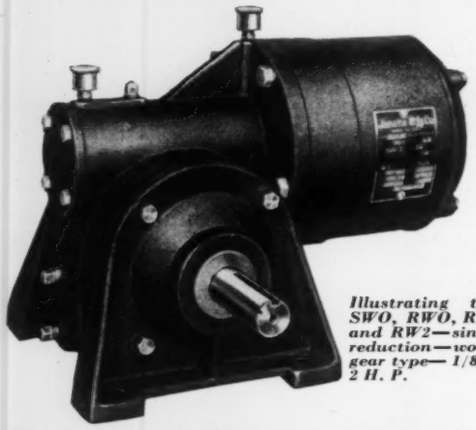


Equip your finest machine tools with Viking Coolant Pumps . . . you'll never regret it. Viking performance and efficiency will put an end to all of your cooling liquid pump problems. Special mounting brackets are available to suit your special installation requirements. Write for complete illustrated bulletins.

VIKING PUMP CO.
CEDAR FALLS, IOWA.

Janette
MOTORIZED SPEED REDUCERS

16 DIFFERENT STYLES
From which to select the type of drive that exactly meets YOUR INDIVIDUAL REQUIREMENTS.



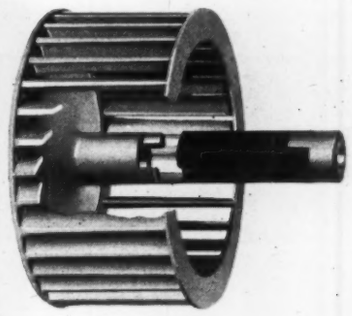
Illustrating the SWO, RWO, RW1 and RW2—single reduction—worm gear type—1/8 to 2 H. P.

The diversity of the Janette custom built line of motorized speed reducers enables us to supply a machine for almost any purpose from 1/30 to 7½ H.P.

Ask for Bulletin 22-25 B

Rotary Converters—Generators—Motors—Motor-Generators
Janette Manufacturing Company
556-558 West Monroe Street Chicago, Ill. U.S.A.
BOSTON - NEW YORK - PHILADELPHIA - CLEVELAND - MILWAUKEE - LOS ANGELES
DETROIT - SEATTLE

resilient coupling has been developed by Lovejoy Flexible Coupling Co., 5009 West Lake street, Chicago. This new type 3-piece, L-R flexible coupling, styled UX, consists of two metal jaw units and a cushion unit made of a solid, round section



Use of rubber in small coupling makes it flexible and noiseless

composed of hard rubber, except where it contacts the metal jaws. Here the rubber is of a softer, more resilient grade. This assembly produces a coupling that is strong and durable, adequately flexible, smooth running and noiseless.

Split Seal Easily Installed

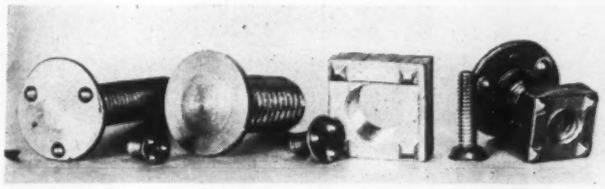
BEARING seal problems are simplified by a new seal brought out by The Garlock Packing Co., Palmyra, N. Y., which may be installed by placing it around the shaft instead of sliding it over the end. The Split-Klozure patented oil seal is split or cut open, and consists of a composition sealing element molded into a cross-sectional shape resembling a modified V, to which is bonded under pressure a finger-type spring. The Split-Klozure seal is suitable for use either on original applications or to replace unit type seal installations when renewal is necessary. The new seals are available in

Sealing material is composition element bonded under pressure to a finger-type spring

sizes for shafts from 3 to 52 inches in diameter. They are made to fit the several packing space widths and recess depths.

Bolts, Nuts for Welding to Surfaces

BOLTS and nuts which may be attached by resistance welding to machine surfaces have been placed on the market by The Ohio Nut & Bolt Co., Berea, O. These fastenings are especially suited to locations where is is difficult to use hand tools. Two of the four types of bolts are made to be easily

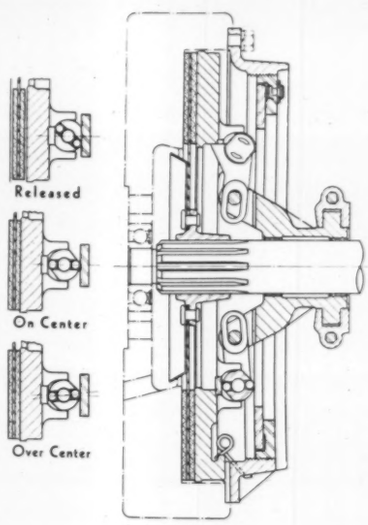


Small protuberances on bolts and nuts permit them to be easily welded to machine surfaces

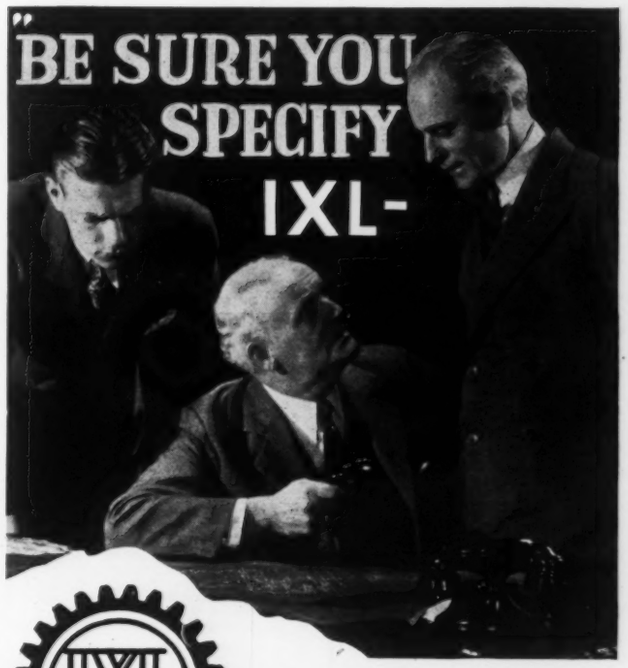
welded to surfaces where it is expedient that the bolt head does not appear on the outside surface. They may be used for supporting appliances which must be either gas or water tight. Threads are American Standard, class 2 fit, maximum thread length on the bolts is 1¼ inches unless otherwise specified.

Frictionless Cam Operates Clutch

EXTREMELY easy operation of the Rockford overcenter clutch is possible with the development of an antifriction roller cam, announced by Rockford Drilling Machine Division, Borg-Warner Corp.,



Cam shafts are forged steel, accurately machined and heat treated for durability



IXL
The Mark of Quality

SPEED REDUCERS!"

This man knows what he wants. He has learned through experience that IXL speed reducers and gearing are the surest answers to his problems. He insists on the dependability—efficiency and long life which he knows IXL equipment will give him.

Manufacturers who use IXL speed reducers and gearing all feel that way. These are some reasons why:

76 years of experience, study and research are behind every IXL unit. Precision manufacturing methods, rigid step-by-step inspection and material tests are constantly used in the IXL plant. The largest and finest equipped plant in the world, devoted exclusively to gear manufacturing. IXL engineering skill is unsurpassed.

These facts help explain why the efficiency, strength and long life of IXL products are recognized by industry. Take these advantages into consideration wherever you need speed reduction and gearing - - and then choose IXL.

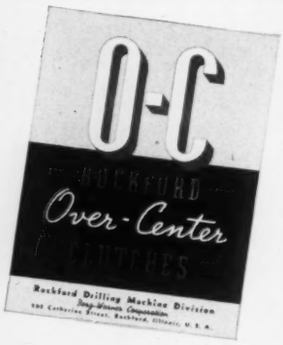
Here's the book that gives the answers.

The IXL Handbook, "Gear Problems" will be sent free to any executive or engineer interested in speed reducers and gearing. Please give title.

FOOTE BROS.
GEAR & MACHINE CORPORATION
5303 S. Western Boulevard - Chicago

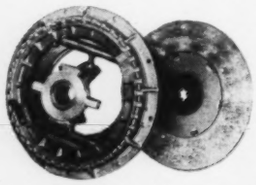
New O-C Circular Is Now Available

Write For Copy



The new O-C Circular contains complete information on sizes, capacities, and uses of Rockford Over-Center Clutches; diagram illustrating relation of parts; sketches showing operation of the anti-friction Roller Cams, a feature exclusive in Rockford O-C Clutches; information on Rockford Power Take-Offs and Spring-Loaded Clutches.

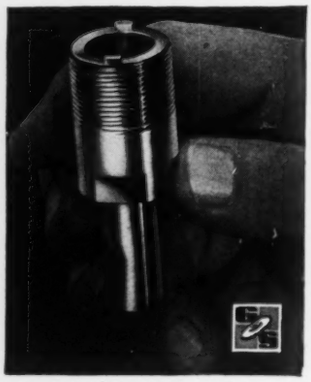
Rockford O-C Clutches are notably successful with gasoline and diesel equipment. They engage smoothly; remain in or out of engagement, regardless of centrifugal force, until position of operating lever or pedal is changed; have simple adjustment, may be interchanged with corresponding Rockford Spring-Loaded Clutches. Write, today, for a copy of the new circular.



Shown above is a 12" Rockford O-C Clutch. Other sizes range from 7" to 20" diameter. They are available with single or double drive plates, for operation in oil or dry; in capacities ranging from 3 to 38 h.p. per 100 r.p.m.

ROCKFORD DRILLING MACHINE DIVISION
Borg-Warner Corporation, 304 Catherine Street, Rockford, Illinois

Precision Screw— Threads



Can be *accurately* ground *out of the solid AFTER HARDENING*

Thus made, distortion errors are corrected and the threads are *clean, smooth*, held to *very close* limits and concentric with axis. These elements are extremely important in high speed spindles and numerous other shafts requiring *true* threads on which a nut can be drawn up "dead square". If you have such problems, consult —

Made to order only No stock No catalog

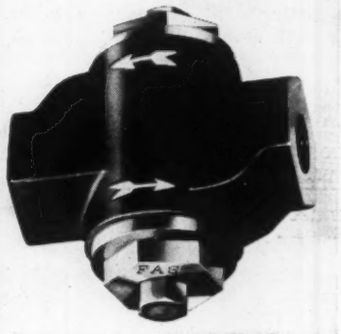
Gear Specialties
INCORPORATED
CHICAGO

2670 W. MEDILL AV. Phone Humboldt 3482

202 Catharine street, Rockford, Ill. This type of release mechanism exerts heavy pressure symmetrically over entire clutch face and contributes substantially to continued operation without adjustment. Hardened and ground rollers bear upon hard steel inserts in pressure plate, and on hardened adjusting ring plate. Over-center clutches are available for operation in oil or dry, remain in or out of engagement until changed by operator; their engagement and pulling power are not affected by centrifugal force.

Valve Controls Air Piston Speed

TO control the speed of an air piston so that it moves at practically constant speed, irrespective of the manipulation of operating valve, is the function of a new speed control valve, just announced by Hanna Engineering Works, Chicago.



Regulation of the admission and exhaust of air from cylinder gives constant speed to piston

Speed control of the air cylinder is accomplished by regulating the admission and exhaust of air to or from each end of the cylinder, independent of the other end. Once set the valve requires no further attention. It is available in sizes of ⅜, ½, ¾ and 1 inch.

Engineering Department Equipment

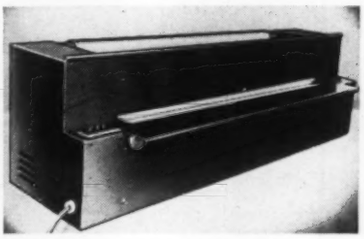
Blueprint Papers Are More Legible

BLUEPRINT papers of a radically new type have been announced by Keuffel & Esser Co., Hoboken, N. J. The improved papers are named "series sixty" and are said to produce prints of an unusually deep blue color, making white lines of the reproductions stand out in sharp, legible contrast. An exceptionally wide printing range is also claimed for series sixty blueprint papers. Tracings of varying transparency can be printed successfully at a single setting of the printing machine. The new papers are handled the same as conventional pa-

pers—printed and washed with the same equipment and procedure.

Printer Uses Mercury Vapor Tube

OF THE continuous type, a mercury vapor tube printer (model 4) for blueprints or black and white prints has been developed by Charles Bruning Co., Inc., 445 Plymouth Court, Chicago. Tracings and paper are carried on a heavy, endless canvas band past a curved contact glass inside of which are mounted two mercury vapor tubes, providing the illumination for exposing the print. Because no resistance is



Low power consumption and exceptional illumination are result of use of mercury vapor light

used in the power circuit these tubes consume 100 watts less per tube than previous models. Greater light output is also gained, as each tube produces 19.5 lumens per watt compared to 14 lumens for the older type. Drive is direct from the motor through a heavy roller chain to the drive roll. The model 4 BW printer is designed for prints up to and including 42 inches in width.

Meetings and Expositions

May 10-12—

American Society of Mechanical Engineers. Machine Shop Practice division meeting to be held at Hotel Sagamore, Rochester, N. Y. C. E. Davies, 29 West Thirty-ninth street, New York, is secretary.

May 9-11—

Machine Tool Electrification Forum. Third annual forum to be held at Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Additional information may be received by writing to the company.

May 11-12—

Refrigerating Machinery Association. Spring meeting to be held at Hot Springs, Va. J. M. Fernald, Southern building, Washington, is president.

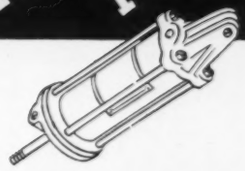
May 13-14—

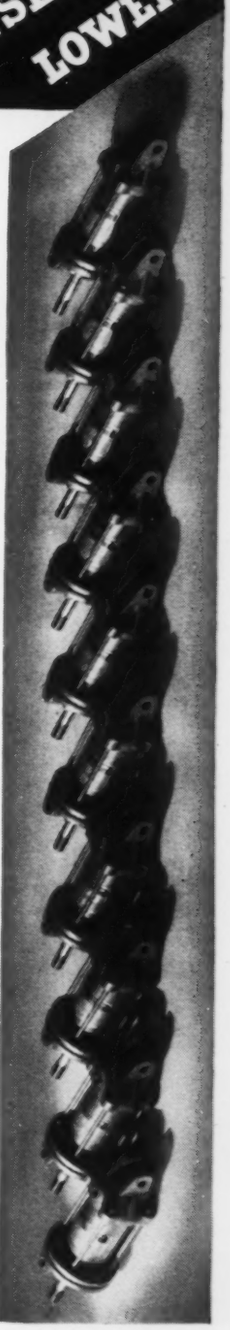
Air-Conditioning Manufacturers' Association. Annual meeting to be held at Hot Springs, Va. J. A. Harlan, Southern building, Washington, is president.

May 14-19—

American Foundrymen's Association. Forty-second an-

MORE Hanna Cylinders ON THEIR WAY TO PUSH PULL RAISE LOWER

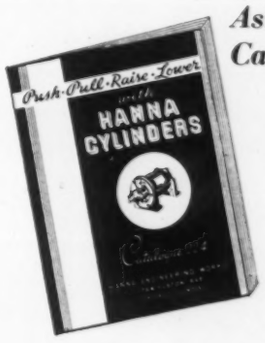




MORE AND MORE the Designing Engineer is taking advantage of the low first cost and economy of operation of Hanna Cylinders for performing operations involving straight line movement.

Overloading causes no problem as the cylinder will stall whereas with a positive, mechanical movement damage may result.

The cushioning effect obtainable with Hanna Air Cylinders is advantageous as jar or shock which might be troublesome is eliminated. There are few if any methods of obtaining motion which can claim to be as flexible in control, as smooth in action and as economical.



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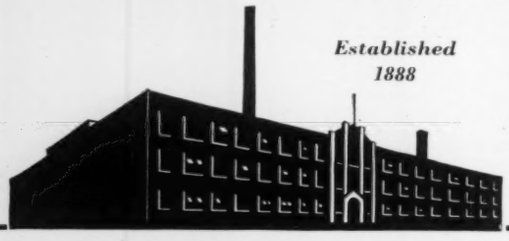
50 YEARS OF GEARS has given us an experience that is invaluable in the manufacture of all types of Gears and Gear Reducers. A thoroughly trained and very competent office and manufacturing personnel operate our modern gear-making plant—this organization enables us to give you the utmost in gears and gear reducers—power-saving products that maintain a performance that is unexcelled.

We have literature, containing engineer data, prices and installations of all types of gears and gear reducers. May we send you your copy?

D. O. JAMES MANUFACTURING COMPANY
1120 W. Monroe St., Chicago, Ill.

Established 1888



AT YOUR SERVICE

Our Staff of Control Engineers

OUR engineers, specialists in the design of metallic bellows to meet specific requirements, will gladly cooperate with you in strictest confidence and without obligation on your part.

Design engineers in many fields are finding Bridgeport Metal Bellows more sensitive, more reliable, more compact and less subject to corrosion than other types of automatic control. They are usually less expensive and are often the ideal answer for remote thermostatic control.

Bridgeport Bellows are made by the hydraulic process which in itself is a test against metal imperfections. And each Bellows is aged and retested before shipment—a double assurance of continuous trouble-free operation.

Every engineer, interested in designing control into his product, should have our free booklet on Bridgeport Bellows. May we send it to you?

Bridgeport knows BELLOWS

BRIDGEPORT THERMOSTAT COMPANY, INC., Bridgeport, Conn.
5251 General Motors Bldg., Detroit, Mich. 30 N. La Salle St., Chicago, Ill.

nual convention to be held at the Public Auditorium, Cleveland. Dan M. Avey, 222 West Adams street, Chicago, is secretary-treasurer.

May 14-21—

International Petroleum exposition to be held in the new Exposition Science Hall, Tulsa, Okla. William B. Way is chairman.

May 15-20—

National Electrical Manufacturers Association. Spring conference to be held at The Homestead, Hot Springs, Va. W. J. Donald, 155 East Forty-fourth street, New York, is managing director.

May 26—

American Iron and Steel Institute. Meeting to be held at Waldorf-Astoria hotel, New York. Walter S. Tower, 350 Fifth avenue, New York, is executive secretary.

June 12-17—

Society of Automotive Engineers. Summer meeting to be held at Greenbrier hotel, White Sulphur Springs, W. Va. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary.

June 13-15—

National Warm Air Heating and Air Conditioning Association. Semi-annual meeting to be held at Plankinton hotel, Milwaukee. Allen W. Williams, 50 West Broad street, Columbus, O., is secretary.

June 13-17—

American Electroplaters' Society. Annual convention to be held at Hotel Schroeder, Milwaukee. W. J. R. Kennedy, 90 Maynard street, Springfield, Mass., is executive secretary.

June 20-22—

Institute of Radio Engineers. Annual meeting and exhibit to be held at Hotel Pennsylvania, New York. Harold P. Westman, 330 West Forty-second street, New York, is secretary.

June 20-23—

American Heating and Ventilating Engineers. Semi-annual meeting to be held at The Homestead, Hot Springs, Va. A. V. Hutchinson, 51 Madison avenue, New York, is secretary.

June 20-24—

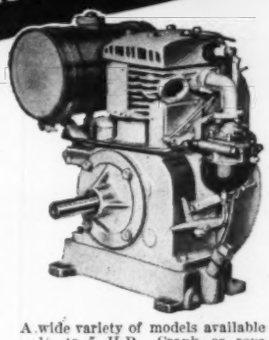
American Institute of Electrical Engineers. National annual summer convention to be held at Mayflower hotel, Washington. H. H. Henline, 33 West Thirty-ninth street, New York, is national secretary.

June 27-30—

American Society of Agricultural Engineers. Annual meeting to be held at Asilomar hotel, Pacific Grove, Calif. Raymond Olney, St. Joseph, Mich., is secretary.

✓ CHECK YOUR GASOLINE MOTORS

✓ For Advanced Modern Design
✓ For Dependability—For Economy
✓ For Trouble-free Performance
✓ For World Wide Reputation



When you select power for gasoline driven machines, choose your gasoline motors for dependable, economical, trouble-free performance.

Hundreds of manufacturers, who use Briggs & Stratton Gasoline Motors endorse them as the most modern and dependable power units. Briggs & Stratton Corporation is the world's largest producer of 4-cycle air-cooled gasoline motors. Send for new literature describing the various models.

BRIGGS & STRATTON CORP.
Dept. MD-5
Milwaukee, Wisconsin, U.S.A.

A wide variety of models available —½ to 5 H.P. Crank or rope starter—standard and high speed — standard and light weight — geared reduction drive — direct mounting crank cases. Also fitted with special accessories. Complete details upon request.

4 CYCLE BRIGGS & STRATTON GASOLINE MOTORS

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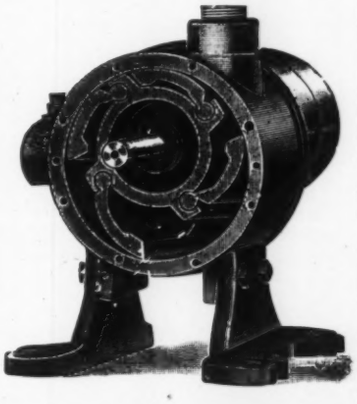

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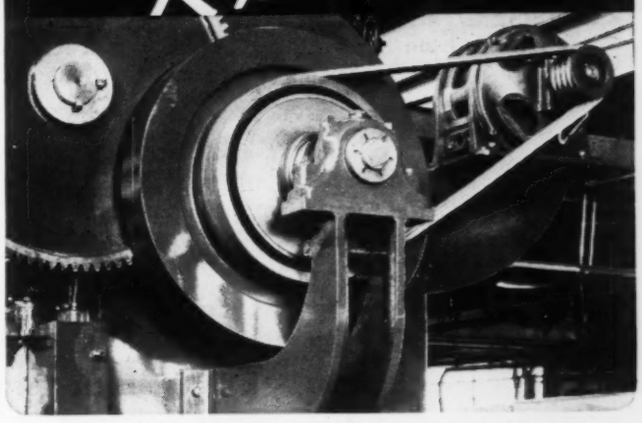

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